DOCUMENT RESUME

ED 183 821 CE 024 380

TITLE	Military Curricula for Vocational & Technical Education. Light Frame Construction I.
INSTITUTION	Naval Construction Training Center, Port Hueneme, Calif.; Ohio State Univ., Columbus. National Center for Research in Vocational Education.
SPONS AGENCY	Bureau of Occupational and Adult Education (DHEW/OE), Washington, D.C.
PUB DATE	May 75
NOTE	243p.; Small type in diagrams will not reproduce well. For a related document see CE 024 381.
EDRS PRICE	MF01/PC10 Plus Postage.
DESCRIPTORS	Behavioral Objectives; *Building Trades; *Construction (Process); Course Descriptions; Criterion Referenced Tests; Curriculum Guides; High Schools; Learning Activities; Lesson Plans; Postsecondary Education; Secondary Education; Teaching Guides; *Trade and Industrial Education; *Woodworking
IDENTIFIERS	Military Curriculum Project

ABSTRACT

This training manual for a secondary-postsecondary-level course in light frame construction I is one of a number of military-developed curriculum packages selected for adaptation to vocational instruction and curriculum development in a civilian setting. Purpose stated for the fifty-hour course is for students to develop the skills required in basic substructure framing, wall framing, and roof framing. The outline of instruction, which suggests number of hours of classroom instruction and shop devoted to each course objective, is based on the following outline: sills and girders, floor joists and solid bridging, subfloors and wall plates, wall members, ceiling and roof construction, gable and studs, and course summarization. The instructor guide lists objectives, texts, references, tools, equipment, materials, training aids, and training aid equipment. Lesson plans for each section contain instructional materials, objectives, criterion tests, homework, and instructor and student activities. Job sheets for use as student handouts include references, tools and equipment, and procedures for performing the tasks. Required chapters from a recommended text are provided. A second text, commercial references, films, and transparencies are suggested. (Light frame construction II course is available--see Note.) (YLB)

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ED183821

Military Curricula for Vocational & Technical Education

LIGHT FRAME CONSTRUCTION

I

CE 024 380

THE NATIONAL CENTER
FOR RESEARCH IN VOCATIONAL EDUCATION
THE OHIO STATE UNIVERSITY

This military technical training course has been selected and adapted by The Center for Vocational Education for "Trial Implementation of a Model System to Provide Military Curriculum Materials for Use in Vocational and Technical Education," a project sponsored by the Bureau of Occupational and Adult Education, U.S. Department of Health, Education, and Welfare.

MILITARY CURRICULUM MATERIALS

The military-developed curriculum materials in this course package were selected by the National Center for Research in Vocational Education Military Curriculum Project for dissemination to the six regional Curriculum Coordination Centers and other instructional materials agencies. The purpose of disseminating these courses was to make curriculum materials developed by the military more accessible to vocational educators in the civilian setting.

The course materials were acquired, evaluated by project staff and practitioners in the field, and prepared for dissemination. Materials which were specific to the military were deleted, copyrighted materials were either omitted or approval for their use was obtained. These course packages contain curriculum resource materials which can be adapted to support vocational instruction and curriculum development.

BUILDERS SCHOOL, LIGHT FRAME CONSTRUCTION I

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Developed by:
United States Navy

Development and Review Dates
May 1975

N.O.

Occupational Area:
Building and Construction

Target Audiences:
Grades 10-adult

Print Pages
202

Cost:
$4.25

Availability:
Military Curriculum Project, The Center for Vocational Education, 1960 Kenny Rd., Columbus, OH 43210

Contents:	Type of Materials: Lesson Plans:	Programmed Text:	Student Workbook:	Handouts:	Text Materials:	Audio-Visuals:	Instructional Design: Performance Objectives:	Tests:	Review Exercises:	Additional Materials Required:	Type of Instruction: Group Instruction:	Individualized:
Unit 1.1 – Introduction												
1.1.2 Safety	•					★	•				•	
Unit 1.2 – Light Frame Structures												
1.2.1 Sills and Girders	•			•	•	★	•	•		★	•	•
1.2.2 Floor Joists and Solid Bridging	•			•	•	★	•	•		★	•	•
1.2.3 Subfloors and Wall Plates	•			•	•	★	•	•		★	•	•
1.2.4 Wall Members	•			•	•	★	•	•		★	•	•
1.2.5 Ceiling and Roof Construction	•			•	•	★	•	•		★	•	•
1.2.6 Gable End Studs	•			•	•		•	•		★	•	•
1.2.7 Course Summarization	•				•		•	•		★	•	•

★ Materials are recommended but not provided.

Course Description

Students completing this short course develop the skills required in basic substructure framing, wall framing, and roof framing.

The course contains materials for both classroom and shop use. These are organized into two units. The first section of Unit 1.1 was deleted because it deals with the military chain of command and specific military procedures. The remaining sections are suitable for vocational program use.

Unit 1.1 – **Introduction** contains a thirty minute lesson on safety procedures.

Unit 1.2 – **Light Frame Structures** contains seven sections covering fifteen hours of classroom instruction and thirty-five hours of shop.

- 1.2.1 – Sills and Girders (3 hours classroom, 3 hours shop)
- 1.2.2 – Floor Joists and Solid Bridging (1 hour classroom, 4 hours shop)
- 1.2.3 – Subfloors and Wall Plates (2 hours classroom, 3 hours shop)
- 1.2.4 – Wall Members (2 hours classroom, 15 hours shop)
- 1.2.5 – Ceiling and Roof Construction (3 hours classroom, 4 hours shop)
- 1.2.6 – Gable End Studs (1 hour classroom, 2 hours shop)
- 1.2.7 – Course Summarization (1 hour classroom, 4 hours shop)

The course training manual contains both teacher and student materials. The teacher materials include instruction on how to use the instructor guide sections and the outline of instruction; lists of training objectives, texts, references, tools, equipment, materials, training aids, and training aid equipment; and the outline of instruction. The outline of instruction contains the lesson plans for each section with an outline of activities for the instructor and the student. Job sheets are provided as student handouts and include references, tools and equipment, and procedures for performing the tasks.

The recommended text is a Navy training manual, *Builder 3 & 2, NAVPERS 10648-F*. The required chapters are provided. A second text is produced commercially and is not provided. Two commercial references are also given. The following films are suggested but not provided:

HOW-016	How to Use Measuring Tools
HOW-018	How to Use Saws
HOW-014	How to Use Hammers
HOW-015	How to Use Hand Boring Tools
MN-67198	Building Technique—Framing Floor Joists and Wall
GIF-001	The Gift of Life
MN-6719-C	Building Technique—Framing, Rafter Principles and Common Rafter

A list of recommended transparencies is also included.

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CHAPTER 10
FOUNDATION CONSTRUCTION AND FLOOR AND WALL FRAMING

The two major parts of a building are (1) the foundation, and (2) the part above the foundation, which is called the SUPERSTRUCTURE. A FRAME building is one in which the skeleton of the superstructure consists of a framework of wooden structural members. This framework is called the FRAMING of the building, and the framing is subdivided into FLOOR FRAMING, WALL FRAMING, and ROOF FRAMING. Floor framing consists for the most part of horizontal members called JOISTS, wall framing for the most part of vertical members called STUDS, and roof framing for the most part of inclined members called RAFTERS.

In the days when lumber and labor were plentiful and nails were scarce, it was the custom to use large-dimension timbers ("4-by," "6-by," "8-by," etc.) for framing members, and to join members together with mortise-and-tenon joints, fastened with wooden pins. As lumber and labor became more expensive, as nails became cheaper, and as the machinery for cutting lumber to smaller dimensions became more highly developed, the large-timber method of framing (called FULL framing) gradually went out of use. Newer methods, in which the framing members consist of small-dimension lumber (usually "2-by") fastened together with nails, are now used.

Of the newer framing methods, the most common is PLATFORM FRAMING (also called WESTERN and STORY-BY-STORY FRAMING). In platform framing there are separate studs for each floor, anchored on SOLE PLATES laid on the subflooring, as shown in figure 10-1.

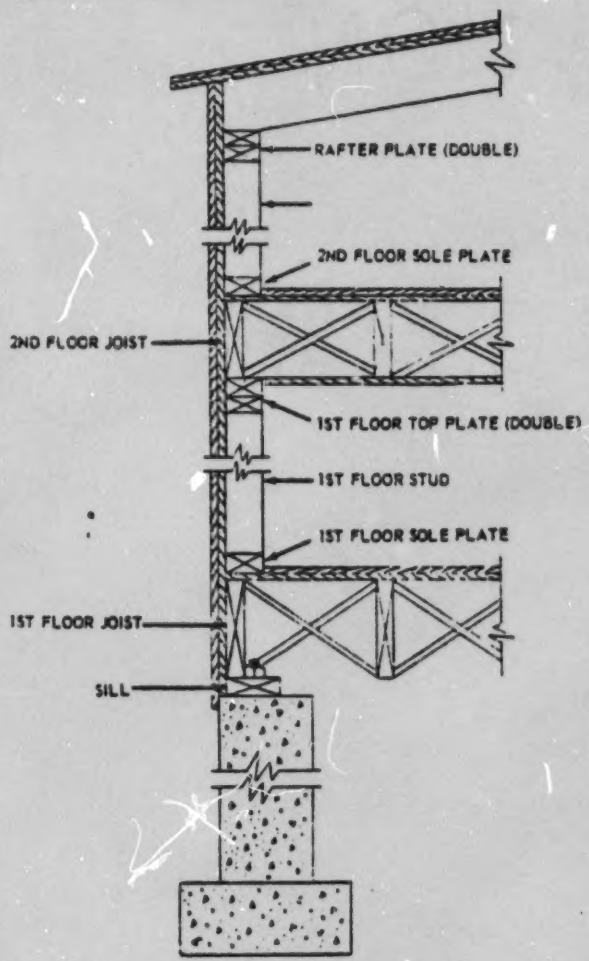

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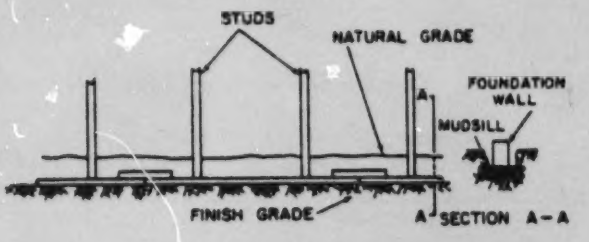
Figure 10-1.—Platform-frame wall section.

FOUNDATIONS

Foundations vary according to their use, the bearing capacity of the soil, and the type of material available. The material may be cut stone, rock, brick, concrete, tile, or wood, depending upon the weight which the foundation is to support. Foundations may be classified as wall or column (pier) foundations.

WALL foundations are built solid, the walls of the building being of continuous heavy construction for their total length. Solid walls are used when there are heavy loads to be carried or where the earth has low supporting strength.

These walls may be made of concrete, rock, brick, or cut stone, with a footing at the bottom (fig. 10-2). The rule of thumb for determining the width or depth of a footing for a foundation is as follows: Width = 2 times thickness of wall; thickness of footing = same as thickness of the wall. This rule of thumb is illustrated in figure 10-3. For complete information regarding the construction of concrete forms, see chapter 6. Because of the time, labor, and material required to build it, this type of wall will be used only when other types cannot be used. Steel rod reinforcements should be used in all concrete walls.



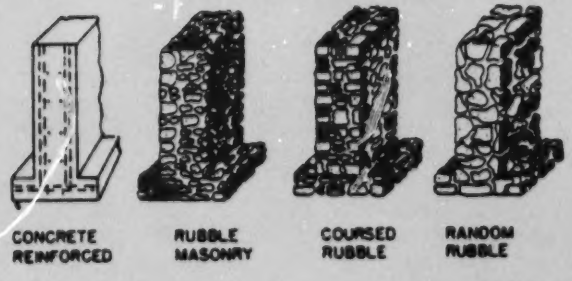


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Figure 10-2.—Foundation walls.

Rubble stone masonry is used for walls both above and below ground and for bridge abutments. It is used when form lumber or masonry units are not available. Rubble masonry may be laid up with or without mortar; if strength and stability are desired, mortar must be used.

Coursed rubble is assembled of roughly squared stones in such a manner as to produce approximately continuous horizontal bed joints. For complete information regarding the use of rubble materials in masonry, see chapter 7.

Random rubble is the crudest of all types of stonework. Little attention is paid to laying the stone in courses. Each layer must contain bonding stones that extend through the wall. This produces a wall that is well tied together.

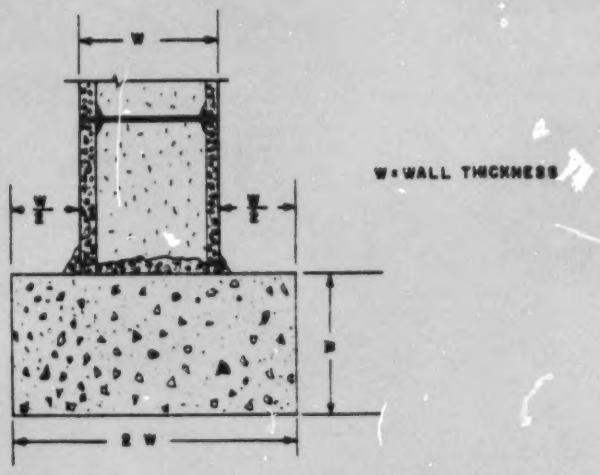

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Figure 10-3.—Dimensions of masonry wall footings.

COLUMN or PIER foundations save time and labor. They may be constructed from masonry or wood. The piers or columns are spaced according to the weight to be carried. In most cases, the spacing is from 6 to 10 feet. Figure 10-4 shows the different types of piers with different types of footing. Wood piers are generally used since they are installed with the least time and labor. Where wood piers are used, braces are necessary (fig. 10-5).

SILL FRAMING

The work involved in sill construction is a very important one for the Builder. The foundation wall is the support upon which all structure rests. The sill is the foundation on which all framing structure rests and it is the real point of departure for actual building and joinery activities. The sills are the first part of the frame to be set in place. They rest either directly on the foundation piers or on the ground, and may extend all around the building; they are joined at the corners and spliced when necessary. Figure 10-6 shows some common types of sills. The type used depends upon the general type of construction used in the frame.

BOX sills are used often with the very common style platform framing, either with or without the sill plate. In this type of sill, the part that lies on the foundation wall or ground is called the sill plate. The sill is laid edgewise on the outside edge of the sill plate.

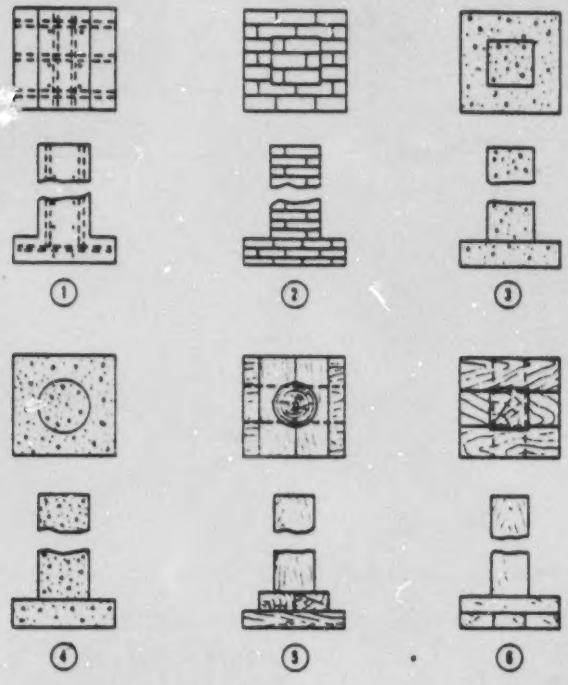

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Figure 10-4.—Column and piers.

There are two types of T-SILL construction; one commonly used in the South, or in dry, warm climates, and one commonly used in the East or less warm climates. Their construction is similar except that in the case of the Eastern T-sill the joists are nailed directly to the studs, as well as to the sills, and headers are used between the floor joists.

The sill shown in the lower portion of figure 10-6 is generally used in braced-framing construction. The floor joists are notched out and nailed directly to the sill and studs.

Where built-up sills are used the joints are staggered (fig. 10-7). The corner joints are made as shown in figure 10-7.

If piers are used in the foundation, heavier sills are used. These sills are of single heavy timbers or are built up of two or more pieces of timber. Where heavy timber or built-up type sills are used, the joints should occur over piers. The size of the sill depends upon the load to be carried and upon the spacing of the piers. The sill plates are laid directly on graded earth or on piers. Where earth floors are used, the studs are nailed directly to the sill plate.

FLOOR FRAMING

The floors of a frame building are supported on a series of JOISTS. Depending upon the length of the SPAN (distance between the end-supports of the joists) and the expected size of the combined live and dead load on the floor, joists may run anywhere from 2 x 4 to 3 x 10 in size. The usual joist size for most ordinary frame construction is 2 x 10. The outside-wall ends of first-floor joists are toenailed to the sill.

In platform framing the outside-wall ends of upper-floor joists are anchored on the lower floor top plates. In most cases they butt against, and are nailed to, a HEADER JOIST, set flush with the outer edge of the plate. This will amount to a repeat of the box-sill framing arrangement used on the first floor.

FRAMING JOISTS TO GIRDERS

The distance between an opposing pair of outside walls is often too great to be spanned by a single joist. When two or more joists are required to cover the span, intermediate support for the inboard joist-ends is provided by one or more girders. First-floor girders are supported on piers or on basement columns; upper floor girders are supported on lower-floor columns. Girders may consist of wood, either solid or LAMINATED (built up of several wooden members spiked or bolted together), or they may consist of steel beams.

Figure 10-8 shows three common methods of framing inside ends of joists to wooden girders. In view A, figure 10-8, the joist ends are lapped on and toenailed to the girder, and spiked to each other. In view B, figure 10-8, the joist ends are notched so as to bear partly on the girder and partly on a LEDGER PLATE nailed to the side of the girder. Again the joists are toenailed to the girder and spiked to each other. Specifications usually require that joists not be notched to more than one-third of their depths. The JOIST HANGER (also called a STIRRUP) shown in view C, figure 10-8 is used when the nature of the construction requires that the upper and lower edges of the joists come flush with the top and bottom of the girder.

There are several ways of framing joists to a steel girder. One is by the use of joist hangers similar to those mentioned in the last section. In the absence of hangers, provision for nailing the joist ends can be made as shown in

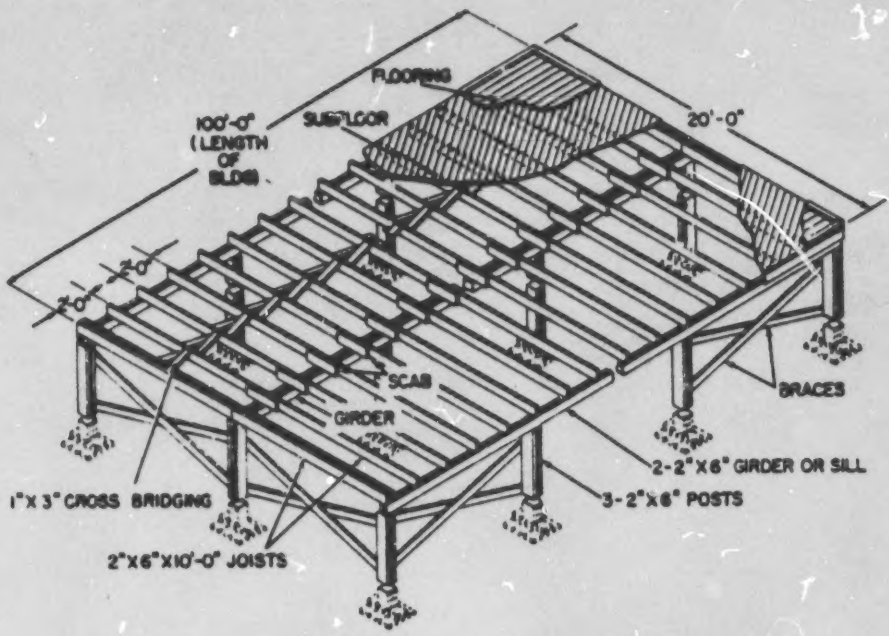

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Figure 10-5.—Braced piers, sills, girders, and joist construction.

figure 10-9. In view A, figure 10-9, the joist ends are lapped on and toenailed to a 2 x 4, which is itself bolted to the upper FLANGE of an I-BEAM girder. The joists are also spiked to each other. In view B, figure 10-9, the ends of the joist are shaped to fit around the upper flange. The ends are butted to each other and each end is anchored on, and toenailed to, a 2 x 4 which is bolted to the WEB (vertical part) of the girder. The joist ends must be shaped so as to leave an allowance of about 3/8 in. (for 2 x 10 joists) above the top of the girder, as shown. This is a SHRINKAGE ALLOWANCE, so called because it allows the wood to shrink without causing the joist ends to split on the girder flange.

FRAMING AROUND FLOOR OPENINGS

Where a floor opening occurs (such as a stairway opening), the parts of the common joists which would extend across if there were no opening must be cut away. The segments remaining on either side of the opening are called CRIPPLE or TAIL joists. The wall-opening ends of cripples are framed against HEADERS as shown in figure 10-10. Specifications usually require that headers be doubled—sometimes tripled.

Headers are framed between the full-length joists which lie on either side of the floor opening. These joists are called TRIMMERS, and they, too, are usually doubled or tripled. Headers up to 6 ft in length are fastened with 20-penny nails, driven through the trimmers into the ends of the headers. Headers more than 6 ft in length should be fastened with joint hangers.

FLOOR FRAMING UNDER PARTITION

A PARTITION is a wall other than one of the outside walls of the structure. An upper-story partition is not always supported by a partition located directly under it on the story below. When it is not, the floor must be strengthened to carry the load of the partition. For a partition running parallel to the lines of the joists, strengthening is accomplished by doubling the joist under the partition (fig. 10-11).

The joist is doubled by nailing two joists to a series of SOLID BRIDGES, usually placed from 14 to 20 in. O.C. The bridges must separate the joists by the width of the partition sole

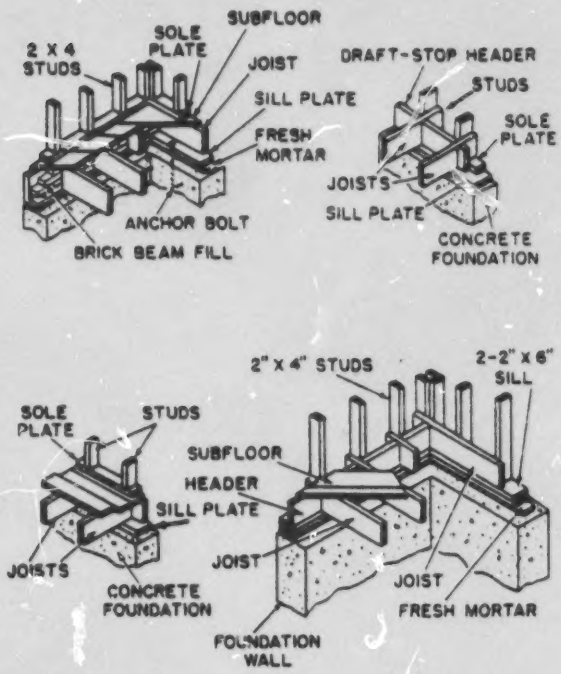

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Figure 10-6.—Types of sills.

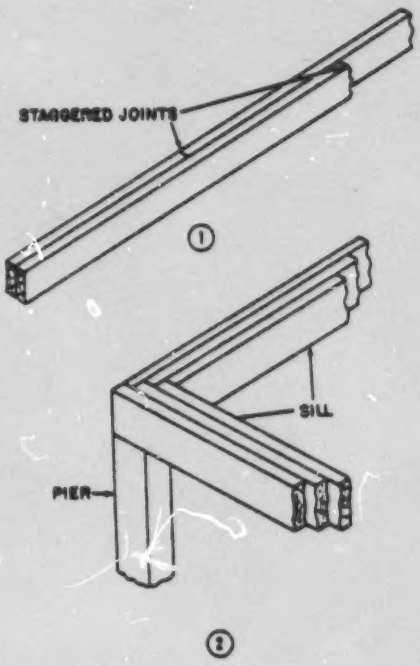

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Figure 10-7.—Sill fabrication.

plate, to ensure that the upper edges of the joists will be available as nailing surfaces for the finish flooring. Sole plate stock, cut in lengths equal to the depth of the joist, is the best material to use for the bridging.

For a partition which runs across rather than parallel to the joists, every other joist in the floor (or every joist, if so specified) is doubled in the same manner.

BRIDGING

The system of bracing the joists to each other is called BRIDGING. The chief purpose of bridging is to hold the joists plumb and in correct alignment, but bridging also serves to distribute part of a concentrated heavy load (such as the weight of a piano) over several joists next to those directly under the load.

There are two types of bridging: CROSS bridging (view A, fig. 10-12) and SOLID bridging (view B, fig. 10-12). Cross bridging consists of pairs of STRUTS (common sizes of strut stock are 1 x 3, 1 x 4, 2 x 2, and 2 x 4), set diagonally between the joists. Solid bridging consists of pieces of joist-size stock set at right angles to the joists and can be staggered for easier installation.

Since cross bridging is more effective than solid bridging, cross bridging is the type most frequently used in modern construction. For joist spans of ordinary length, specifications usually require a row of cross bridging for every 5 to 8 ft of span. For unusually long spans, the maximum distance between rows of bridging is about 6 ft.

The required length of a cross-bridging strut and the required angle of cut for the ends may be figured as follows: select a piece of board equal in width to the ACTUAL depth of a joist, and 4 or 5 in. longer than the specified spacing of joists O.C. Square two lines across the board, separated from each other by a distance

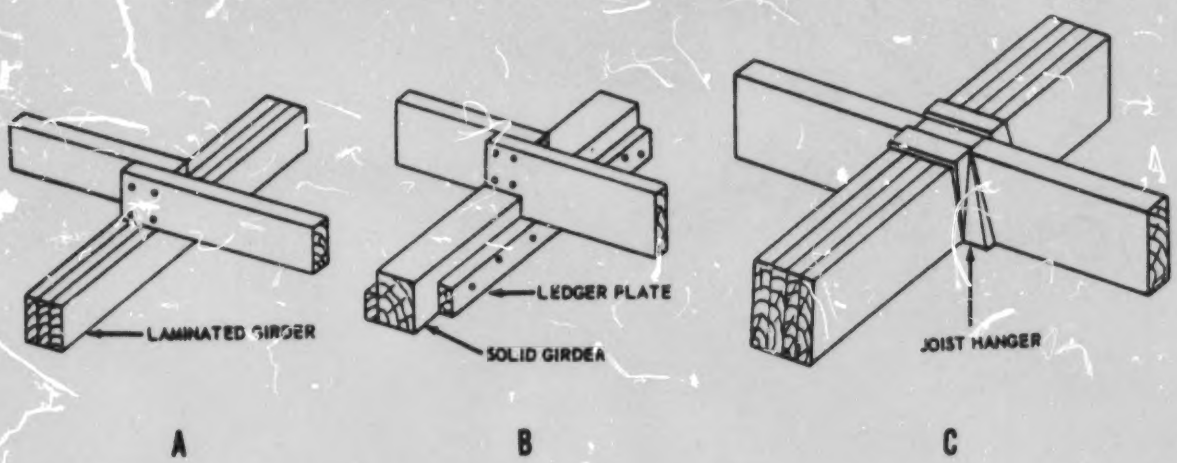

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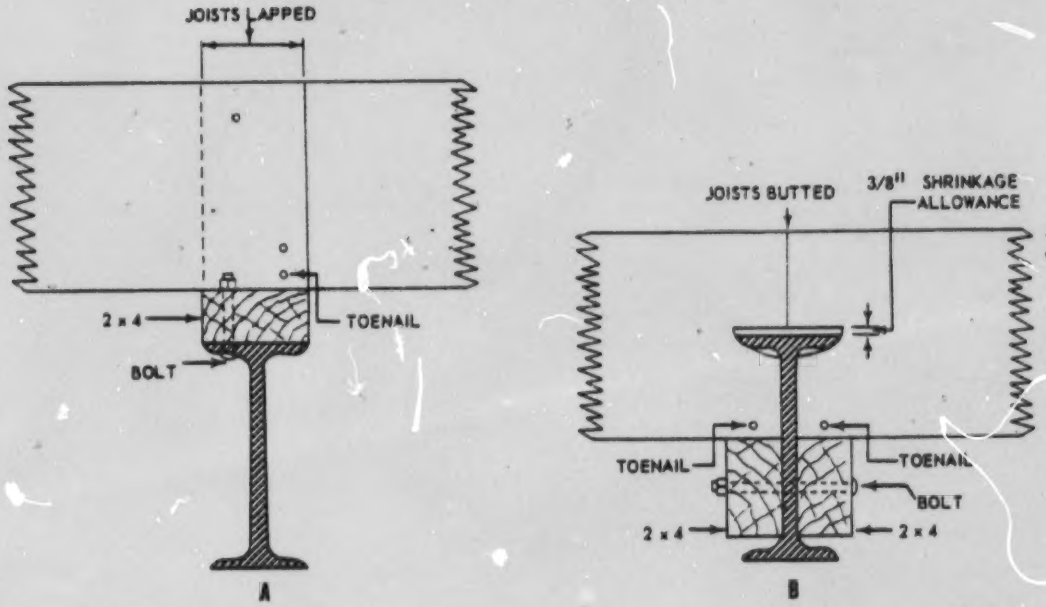
Figure 10-8.—Methods of framing joists to wooden girders.



133.92

Figure 10-9.—Methods of framing joists to steel girders.

between the two joists. These two lines represent the opposing faces of two adjacent joists.

Next, sketch in the edge outline of one of the struts, as shown in figure 10-13, using the ACTUAL thickness of the material. The measured length of this outline is the required length of a strut. To cut struts to this length and to the correct end-angle, proceed to make a miter box as follows:

First, edge-butt a length of 2 x 4 to a length of 2 x 6, as shown in the second and third views of figure 10-14. Then set the framing square on the layout as shown in the first view, with a convenient figure on the tongue intersected by the lower end of the strut outline. Note the figure that the outline intersects on the blade, as indicated. Set the framing square to this cut on the upper edge of the 2 x 6, as shown in

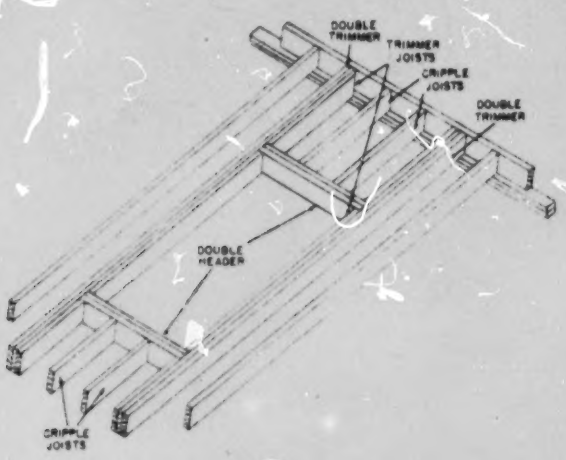


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Figure 10-10.—Framing around floor opening.

the second view, and draw a line along the tongue.

A kerf sawed square from this line will guide the saw at the correct angle for making the end cuts. Measure off from the kerf the length of a strut, and nail a stop block to the miter box at this point, as shown in the third view. Struts may now be sawed to correct length and correct angle by placing the strut stock on edge in the miter box with the end against the stop block.

The bridging is installed after the joists have been set in place, but before the subfloor is laid. At this time only the upper ends of the struts are nailed. The nailing of the lower ends is postponed until after the joists have adjusted to the weight of the subflooring.

SUBFLOORING

Since the subflooring helps to hold the joists plumb and rigid, it is considered to be a structural element and therefore a part of the framing. The specifications usually refer to the subflooring in language similar to the following:

Subfloors. Joists shall be floored with No. 2 common 6-in. sheathing, laid close and straight [or diagonal] and double-nailed at each joist crossing.

Unless otherwise specified, lumber for subflooring is usually square-edged. Unless boards are END-MATCHED (shaped on the ends to

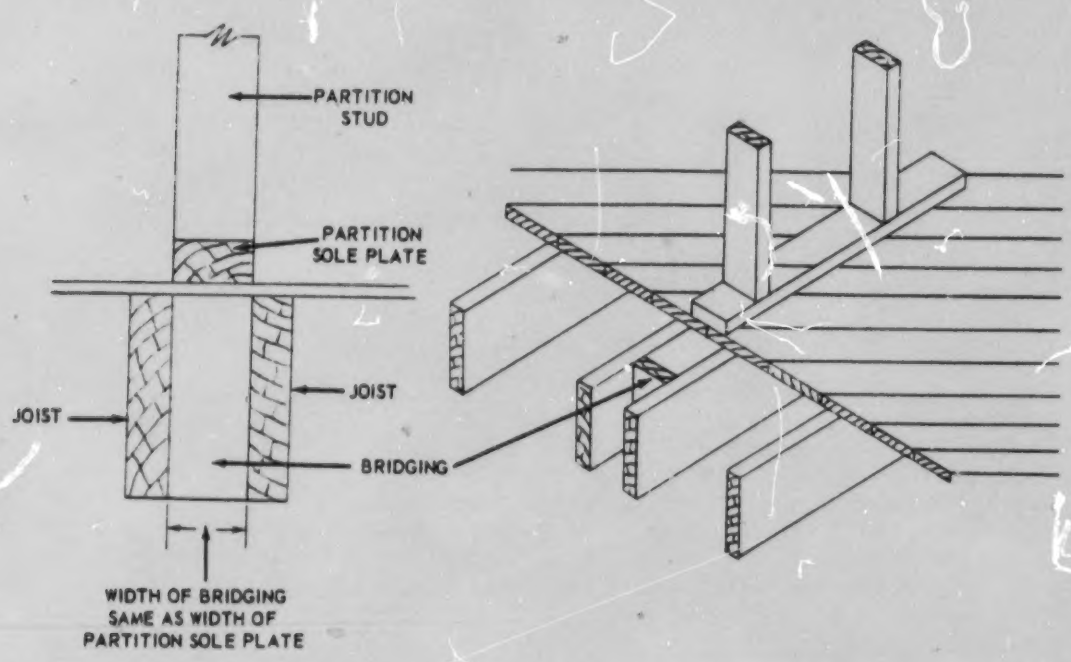

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Figure 10-11.—Method of doubling joist under partition.

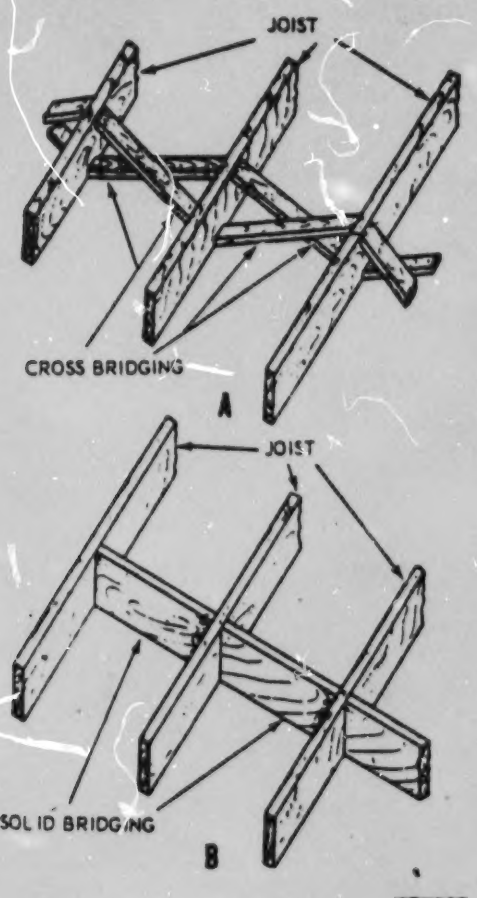

Figure 10-12.—Cross bridging and solid bridging.

form tongue-and-groove end joints), they must be cut so as to bring end joints over joists.

Wood flooring expands considerably when it is wetted, and the subflooring may be wetted repeatedly during construction operations. If the flooring were laid so as to butt against the inner faces of studs (for example), expansion of the subflooring could push the studs out of line. Besides the marginal expansion space, a space of about 1/2 in. should be left between boards at intervals of about 6 ft across the floor.

Straight-laid subflooring is laid at a 90° angle to the lines of the joists; diagonal-laid subflooring at a 45° angle. To ensure that the lines of end joints will be parallel to the lines of the joists, straight-laid boards must be cut off square, and diagonal-laid boards mitered to 45°.

Straight-laid subflooring is started at a wall line; diagonal-laid subflooring at a corner. The first board laid is called the STARTER BOARD. The starter board for diagonal-laid subflooring is a small piece shaped like a 45° triangle.

Subflooring is nailed down with two 8-penny nails at each joist crossing—with 4 nails (2 in each board) at every crossing where an end joint between boards occurs.

WALL FRAMING

Wall framing (fig. 10-15) is composed of regular studs, diagonal bracing, cripples, trimmers, headers, and fire blocks and is supported by the floor sole plate. The vertical members of the wall framing are the studs, which support the top plates and all of the weight of the upper part of the building or everything above the top plate line. They provide the framework to which the wall sheathing is nailed on the outside and which supports the lath, plaster, and insulation on the inside.

Walls and partitions which are classed as framed constructions are composed of structural elements (fig. 10-16) are usually closely spaced, slender, vertical members called studs. These are arranged in a row with their ends bearing on a long horizontal member called a bottom plate or sole plate, and their tops capped with another plate, called a top plate. Double top plates are used in bearing walls and partitions. The bearing strength of stud walls is determined by the strength of the studs.

CORNER POSTS

The studs used at the corners of the frame construction are usually built up from three or more ordinary studs to provide greater strength. These built up assemblies are corner-partition-posts. After the sill and first-floor joists are in place, the sub-floor is placed to give a surface upon which to work. The corner posts are set up, plumbed, and temporarily braced. The corner posts may be made in several different ways (fig. 10-17).

A corner post may consist of a 4 by 6 with a 2 by 4 nailed on the board side, flush with one edge. This type corner is for a 4-inch wall. Where walls are thicker, heavier timber is used.

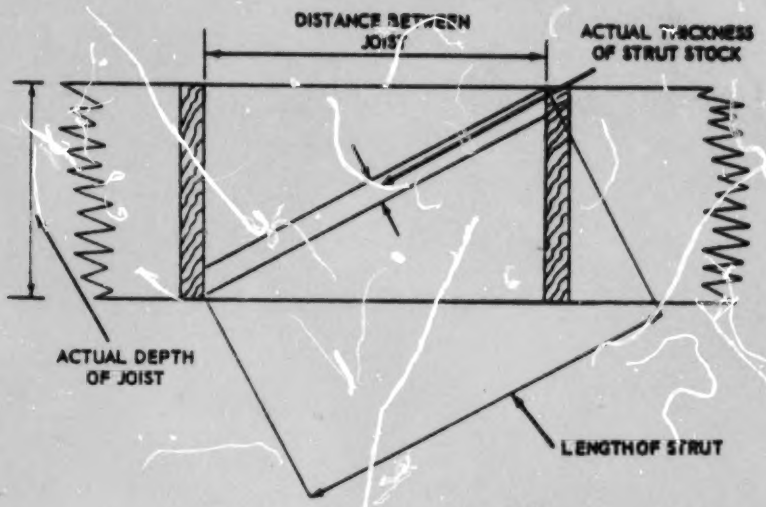

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Figure 10-13.—Layout for cross-bridging (struts).

A 4 by 4 may be used with a 2 by 4 nailed to two of the adjoining sides.
Two 2 by 4's may be nailed together with blocks between and a 2 by 4 flush with one edge.
A 2 by 4 may be nailed to the edge of another 2 by 4, the edge of one flush with the side of the other. This type is used extensively where no inside finish is required.

Whenever a partition meets an outside wall, a stud wide enough to extend beyond the partition on both sides is used; this affords a solid nailing base for the inside wall finish. This type of stud is called a T-POST and is made in several different ways (fig. 10-18).

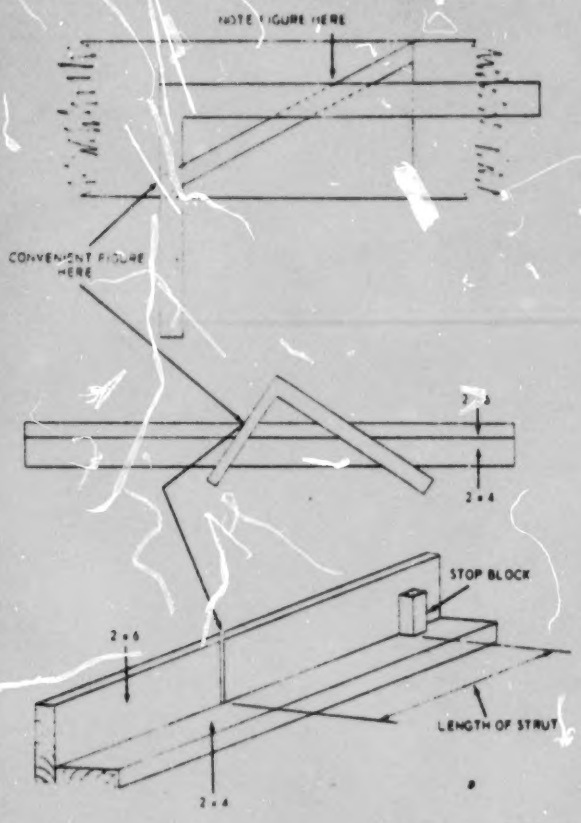
A 2 by 4 may be nailed and centered on the face side of a 4 by 6.
A 2 by 4 may be nailed and centered on two 4 by 4's nailed together.
Two 2 by 4's may be nailed together with a block between them and a 2 by 4 centered on the wide side.
A 2 by 4 may be nailed and centered on the face side of a 2 by 6, with a horizontal bridging nailed behind them to give support and stiffness.

Where a partition is finished on one side only, the PARTITION POST used consists of a simple stud, set in the outside wall, in line with the side of the partition wall, and finished as stud *A* in 1, figure 10-19. These posts are nailed in place along with the corner post. The exact position of the partition walls must be determined before the posts are placed. Where the walls are more than 4 inches thick, wider timber is used. In special cases, for example where partition walls cross, a double T-post is used. This is made by using methods previously described and nailing another 2 by 4 to the opposite wide side, as shown in 2, 3, and 4, figure 10-19.

STUDS

After the posts, plates, and braces are in place, the studs are placed and nailed with two-16- or 20-penny nails through the top plate. Before the studs are set in place, the window and door openings are laid out. Then the remaining or intermediate studs are laid out on the sole plates by measuring from one corner the distances the studs are to be set apart. Studs are normally spaced 12, 16, and 24 inches on centers, depending upon the type of building and the type of outside and inside finish. Where vertical siding is used, studs are set wider apart since the horizontal girts between them afford nailing surface.

When it is desirable to double the post of the door opening, first place the outside studs into position and nail them securely. Then cut short



133.96

Figure 10-14.—Making a miter box for cutting cross-bridging struts.

studs, or FILLER STUDS, the size of the opening, and nail these to the inside face of the outside studs as shown in figure 10-15. In making a window opening, a bottom header must be framed; this header is either single or double. When it is doubled, the bottom piece is nailed to the opening studs at the proper height and the top piece of the bottom header is nailed into place flush with the bottom section. The door header is framed as shown in figure 10-15. The filler stud rests on the sole at the bottom.

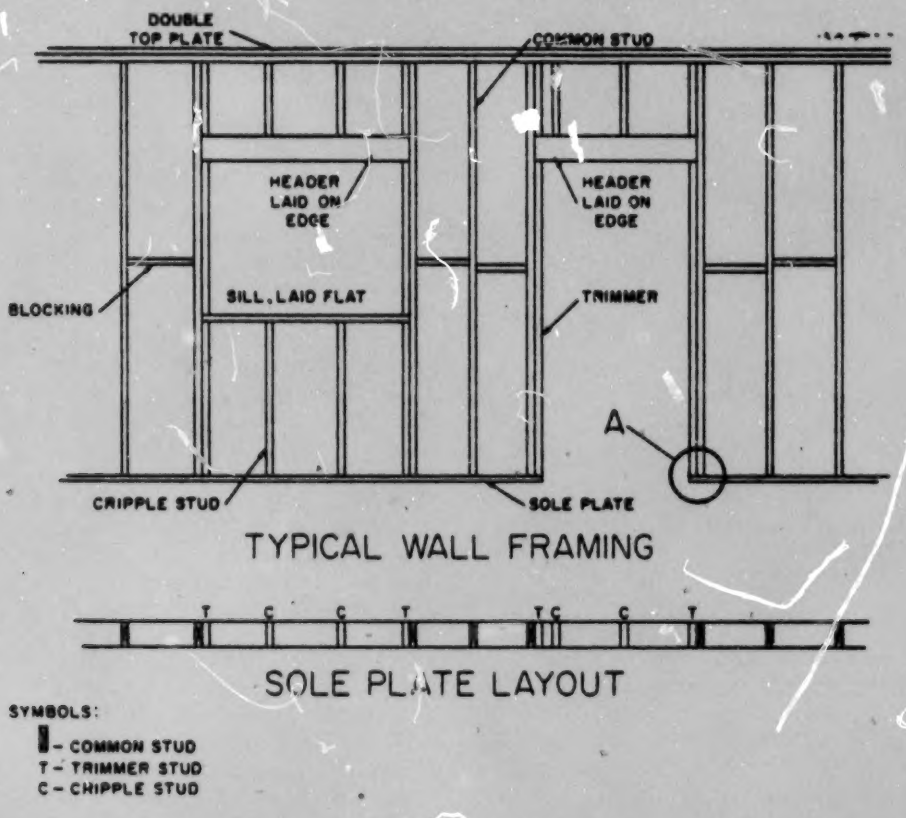
TOP PLATE AND SOLE PLATE

The top plate serves two purposes—to tie the studding together at the top and form a finish for the walls; and to furnish a support for the lower ends of the rafters (fig. 10-15). The top plate serves as a connecting link between the wall and the roof, just as the sills and girders are connecting links between the floors and the walls. The plate is made up of one or two pieces of timber of the same size as the studs. (In cases where the studs at the end of the building extend to the rafters, no plate is used at the end of the building.) When it is used on top of partition walls, it is sometimes called the cap. Where the plate is doubled, the first plate or bottom section is nailed with 16- or 20-penny nails to the top of the corner posts and to the studs; the connection at the corner is made as shown in 1, figure 10-20. After the single plate is nailed securely and the corner braces are nailed into place, the top part of the plate is then nailed to the bottom section by means of 16- or 20-penny nails either over each stud, or spaced with two nails every 2 feet. The edges of the top section should be flush with the bottom section and the corner joints lapped as shown in 1 and 2, figure 10-20.

All partition walls and outside walls are finished either with a 2 by 4 or with a piece of timber corresponding to the thickness of the wall; this timber is laid horizontally on the floor or joists. It carries the bottom end of the studs (fig. 10-15). This 2 by 4, or timber, is called the "sole" or "sole plate." The sole should be nailed with two 16- or 20-penny nails at each joist that it crosses. If it is laid lengthwise on top of a girder or joist, it should be nailed with two nails every 2 feet.

PARTITION

Partition walls are walls that divide the inside space of a building. These walls in most cases are framed as part of the building. In cases where floors are to be installed after the outside of the building is completed, the partition walls are left unframed. There are two types of partition walls: the bearing, and the nonbearing types. The bearing type supports ceiling joists. The nonbearing type supports only itself. This type may be put in at any time after the other framework is installed. Only one cap or plate is used. A sole plate should be used in every case, as it helps to distribute the load over a larger area. Partition walls are framed in the same manner as outside walls, and door openings are framed as outside openings. Where there are corners or where one partition wall joins another, corner posts or T-posts are used as in the outside walls; these posts provide nailing surfaces for the inside wall finish. Partition walls in a one-story



133.354

Figure 10-15.—Typical wall frame details.

building may or may not extend to the roof. The top of the studs has a plate when the wall does not extend to the roof; but when the wall extends to the roof, the studs are joined to the rafters.

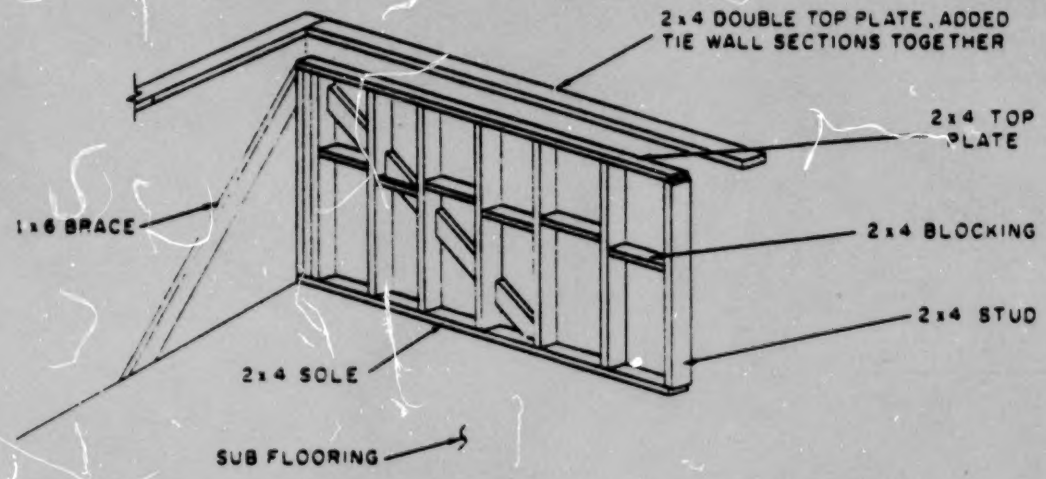
BRACES

Bracing stiffens framed construction and helps it to resist winds, storm, twist, or strain stemming from any cause. Good bracing keeps corners square and plumb and prevents warping, sagging, and shifts resulting from lateral forces that would otherwise tend to distort the frame and cause badly fitting doors and windows and the cracking of plaster. There are three commonly used methods of bracing frame structures.

Let-in bracing (1, fig. 10-21). Let-in bracing is set into the edges of studs so as to be flush with the surface. The studs are always cut to let in the braces; the braces are never cut. Usually 1 by 4's or 1 by 6's are used, set diagonally from top plates to sole plates.

Cut-in bracing (2, fig. 10-21). Cut-in bracing is toenailed between studs. It usually consists of 2 by 4's cut at an angle to permit toenailing, inserted in diagonal progression between studs running up and down from corner posts to sill or plates.

Diagonal sheathing (3, fig. 10-21). The type of bracing with the highest strength is sheathing applied diagonally. Each board acts as a brace of the wall. If plywood sheathing 5/8-inch thick or more is used, other methods of bracing may be omitted.


2 x 4 DOUBLE TOP PLATE, ADDED TO TIE WALL SECTIONS TOGETHER
2 x 4 TOP PLATE
1 x 6 BRACE
2 x 4 BLOCKING
2 x 4 STUD
2 x 4 SOLE
SUB FLOORING
WALL SECTION INPLACE WITH TEMPORARY BRACING

133.355

Figure 10-16.—Typical wall construction.

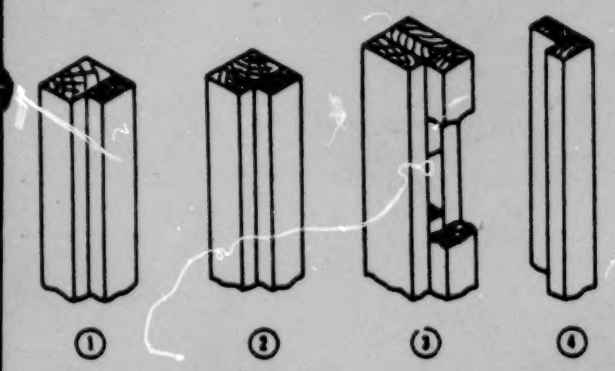


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Figure 10-17.—Corner post construction.

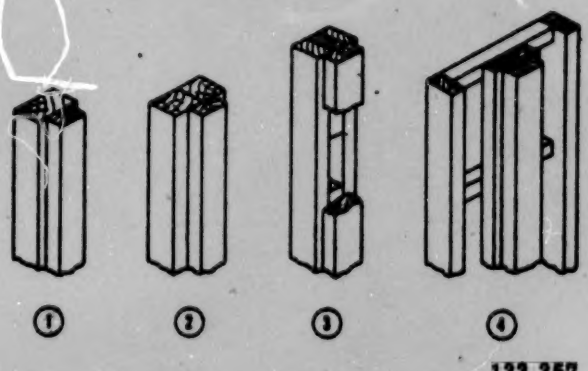

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Figure 10-18.—T-post construction.

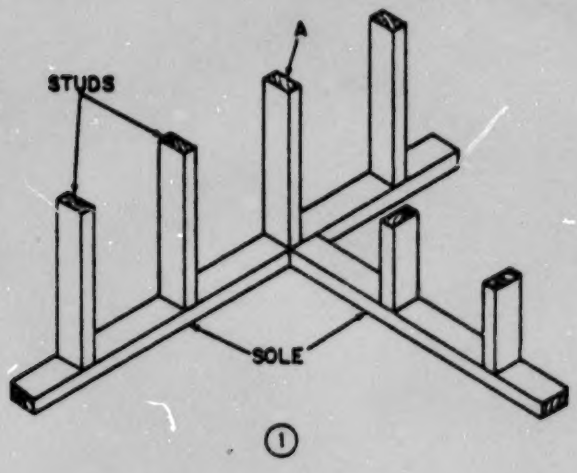
FRAMING LAYOUT AND ERECTION

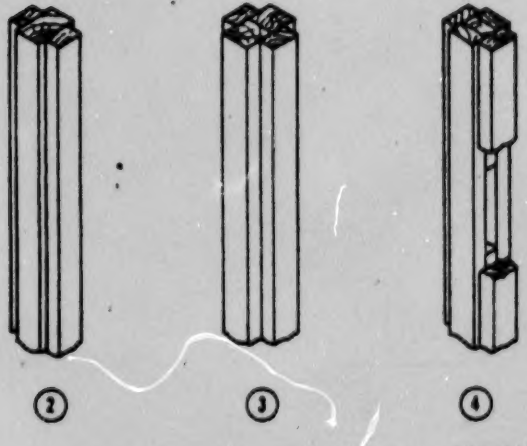
Framing LAYOUT consists principally of laying out the various framing members for cutting to correct lengths, and marking the correct locations of members on other members to which they are to be joined.

SILL LAYOUT

The sill is normally the first member to be laid out. As indicated in figure 10-1, the edge of the sill is usually set back from the edge of the foundation a distance equal to the thickness of the sheathing. When this is the case, the length of sill stock required to cover a section of foundation wall is equal to the length of the wall section minus twice the amount of the set-back.

To make up this length you should select lengths of sill stock which will most conveniently and economically make up the total required length. Suppose, for example, that the section of wall calls for 33 ft of 2 x 8 sill stock



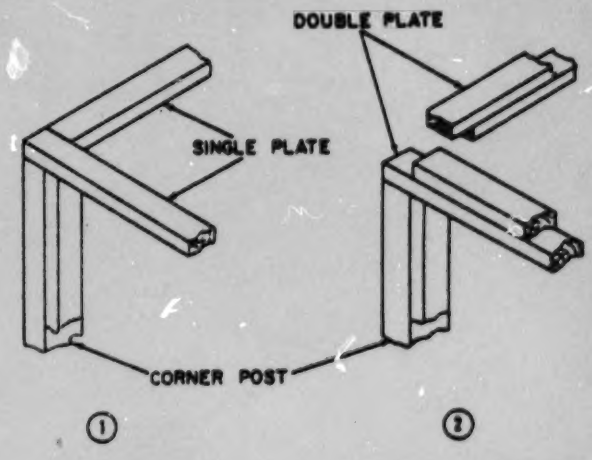


133.358

Figure 10-19.—Partition posts.

and you have 2 x 8 available in 18-ft, 16-ft, 14-ft, and 6-ft lengths. You could select two 18-ft pieces and cut 3 ft off one of them, or you could select two 14-ft pieces and a 6-ft piece and cut a foot off the 6-ft piece. In the first instance, however, you would have 3 ft of waste, while in the second you would have two joints in the sill. To minimize both waste and the number of joints, you should select one 18-ft and one 16-ft piece and cut a foot off one of them.

Once the required length has been made up, the next step is to lay out the locations of the bolt holes as follows: place each piece of sill stock on the foundation, inboard of the bolts, but otherwise in exactly the position it is to occupy, and square a line across the stock from



133.359

Figure 10-20.—Plate construction.

the center of each bolt. To lay out the bolt-hole center on each of these lines, measure the distance from the center OF EACH BOLT to the outer edge of the foundation; subtract the amount of the sill set-back from this distance, and lay off the remainder ON THE CORRESPONDING BOLT LINE, measuring from what is to be the outer edge of the sill.

The reason you must lay out each bolt hole separately is that the bolts may be set at slightly varying distances from the edge of the foundation and from each other.

SILL PLACEMENT

Bore the bolt holes with an auger bit 1/8 in. larger in diameter than the bolt diameter, to allow for making slight adjustments in the location of the sill. When all the holes have been bored, try the stock for the whole section on the bolts for a fit. If the fit is satisfactory, remove the pieces of stock and place a thin layer of mortar on top of the foundation. Replace the pieces and check the whole sill for line and level. Place small wedges, if necessary, to hold pieces level until the mortar sets. Then place the washers on the bolts, screw on the nuts, and bolt the sill down.

JOIST LAYOUT

A COMMON JOIST is a full-length joist, as distinguished from a cripple joist. The best way to lay out common joists for cutting is to figure the correct length of a common joist,

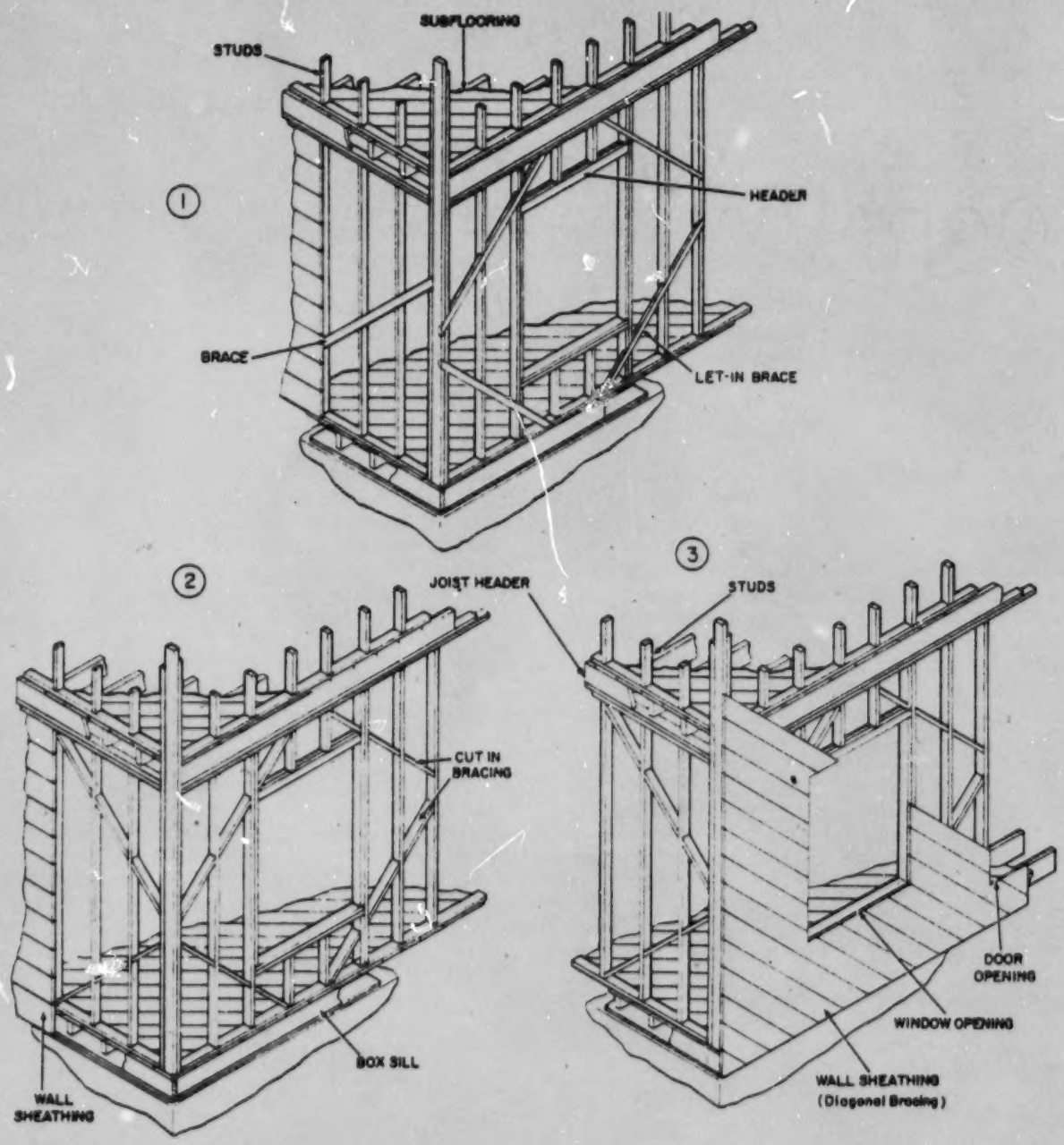


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Figure 10-21.—Common types of bracing.

cut a piece of stock to this length, notch for identification, and use the piece as a PATTERN from which to cut the other common joists. The best way to lay out cripples for cutting is to postpone the cripple layout until after the headers have been placed; then measure the spaces which are to be spanned by the cripples.

In platform framing, the outer ends of the joists usually butt against a header joist which is set flush with the outer edge of the sill. In this case the length of a wall-to-wall common joist will be the distance between the outer edges of the sills, minus twice the thickness of a header joist.

The length of common joist required to cover a given span between an outside wall and a girder varies with the character of the wall framing and also with the manner in which the joists are framed to the girder. The length of common joist required to cover a given span between two girders varies with the manner in which the joists are framed to the girders. Joists which lap a girder with full bearing (meaning joists which extend all the way across the top of the girder) must obviously be longer than joists which butt each other on the top of a girder. Joists in hangers, which butt against the sides of a girder, are shorter than joists which butt each other on top of a girder.

The whole floor-framing situation, then, must be studied closely before a common joist pattern is cut. Whenever possible, the cutting of a pattern should be delayed until the sills, headers, and other supporting or abutting members are erected. The joist length can then be determined by measurements taken on the actual structure. Whenever possible, too, the common joist pattern should be tried on the actual structure for a fit before any joists are cut from it.

JOIST LOCATION LAYOUT

The location of a joist end is marked on a sill or a header joist by squaring a line across and drawing an X alongside it. The X indicates the side of the line on which the joist end-section is to be placed.

The location of one of the outside joists is marked first, and the locations of the others are then measured off from this one in accordance with the specified spacing of joists O.C.

Figure 10-22 shows the method of laying out joist locations on the header joists in a platform-frame box sill, in which the headers and outside joists come flush with the outer edges of the sill.

Before you start laying out the joist locations you should study the floor framing plan to learn the locations of any double trimmers around floor openings. Locations of double trimmers are marked with two lines and two X's. The locations of cripples are marked the same as the locations of common joists, but with the word CRIP written in alongside.

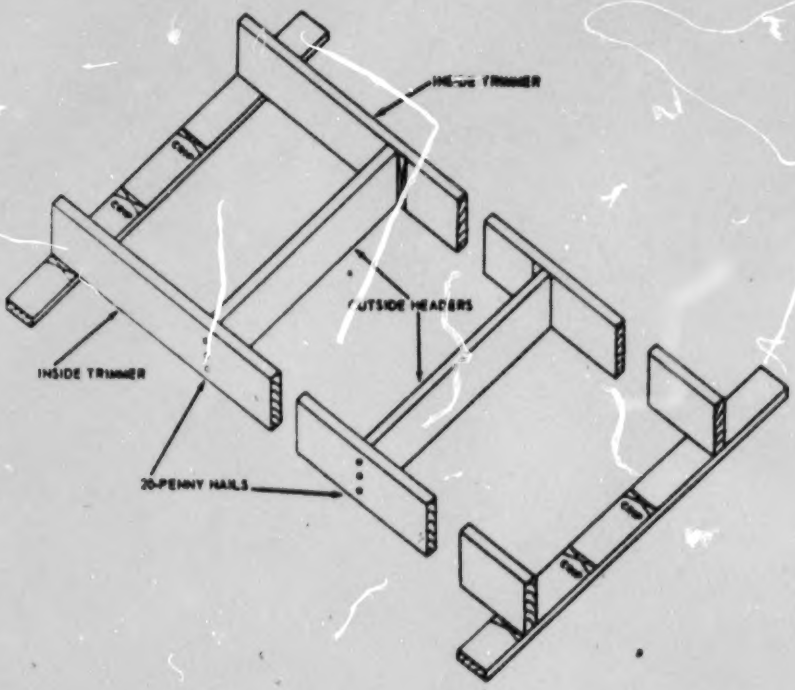
JOIST ERECTION

The usual procedure for erecting joists is as follows: if there are any header joists, these joists are cut and erected first. As a general rule, the length of a platform-frame header is equal to the shortest distance between the outer edges of the sills. Header joists are toenailed to the sills with 16-penny nails spaced 16 in. O.C.

As soon as a common joist pattern has been laid out and cut as previously described, a CUTTING PARTY starts cutting common joists. As each joist is cut, a 2-man CARRYING PARTY carries it to its location and lays it flat across the span. A 2-man CONSTRUCTION PARTY (one man at each end of the span) erects the outside joists first. Each of these is toenailed down to the sill or plate with 16-penny nails spaced 16 in. O.C., and end-nailed through the headers with two 20-penny nails driven into each joist end. Incidentally, many joists have a slight curve to them, and the convex edge of a joist is called the CROWN. A joist should always be placed with the crown UP.

Next the joists lying between the outside joists are set on edge and the ends of each joist are toenailed down to the sill or plate with two 16-penny nails, one on each side of the joist. Only the inner trimmer of each pair of trimmers is erected at this time, and no cripples are cut at this time. After all the common joists, and the trimmers as mentioned, have been set on edge and toenailed, the joists are plumbed and temporarily braced as follows.

A temporary brace (usually a 1 x 6) is laid across the tops of the joists at the center of the span. The outer ends of this brace are tacked down to the outside joists with 8-penny nails, driven only part-way in to allow for extracting later when the brace is removed. Beginning with the joist next to an outside joist, the joists are plumbed consecutively, and as each joist is plumbed it is braced with an 8-penny nail, driven through the brace into the joist.



133.105

Figure 10-23.—First step in framing around floor opening.

each end, driven through the trimmers into the ends of the headers (fig. 10-25). Finally, the outside trimmers are set in place and nailed to the inside trimmers with 16-penny nails spaced 12 in. O.C., as shown in figure 10-26.

As soon as enough common joists have been erected, the installation of bridging begins. Cross-bridging struts are nailed (usually with 8-penny nails) at the top ends only at this time. Bottom ends will be nailed from below, after the joists have adjusted themselves to the weight of the subflooring. Remember the joist should be placed with the crown up, so that any settlement under the weight of the flooring will tend toward a level instead of toward a sag.

After the bridging is installed, the subflooring is laid as previously described. In the meantime, the layout and cutting of studs begins.

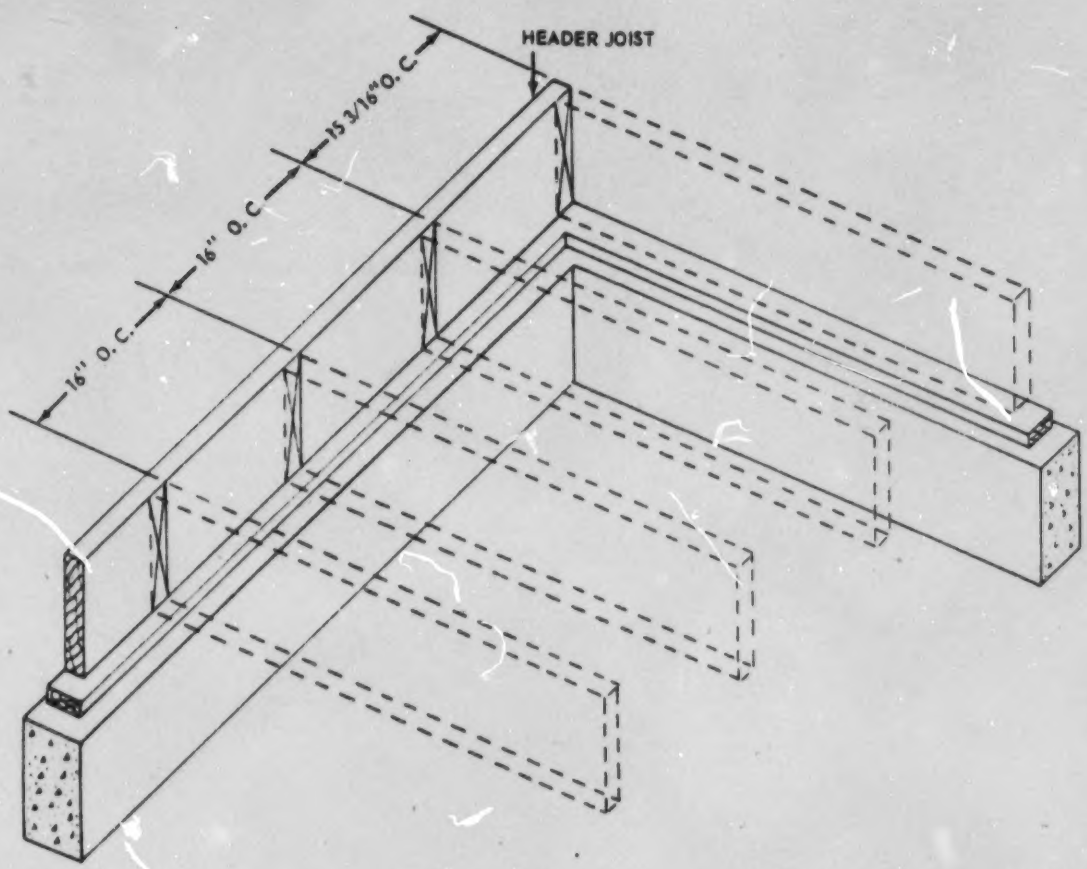
LAYING OUT STUDS FOR CUTTING

Before you can lay out any studs for cutting, you must calculate how long the studs must be. The best way to do this is to lay out to full scale on a piece of stud stock certain data obtained from the wall sections and elevations, and then use the piece of stock as a pattern for cutting studs.

Next step is to lay out the segments of the gable-end studs which extend above the level of the top of the rafter plate. In order to do this, you must calculate the COMMON DIFFERENCE of gable-end studs as follows.

In figure 10-27 the line AC indicates the level of the side wall rafter plate, and line AB indicates the roof line of the building. Somewhere on the elevations you will find a small triangle like the one shown in the upper left of the figure. This is called the ROOF TRIANGLE, and it gives the proportion of run to rise in the roof. In this case this is also the proportion of run to rise between line AC and line AB, and the proportion is 8 inches of rise to every 12 inches of run.

The lines DE and FG represent the portions of two gable-end studs that extend above the level of the top of the side-wall rafter plate. You can calculate the length of DE as follows. Since the studs are spaced 16 in. O.C., the run of the right triangle AED is 16 in. The rise of



133.104

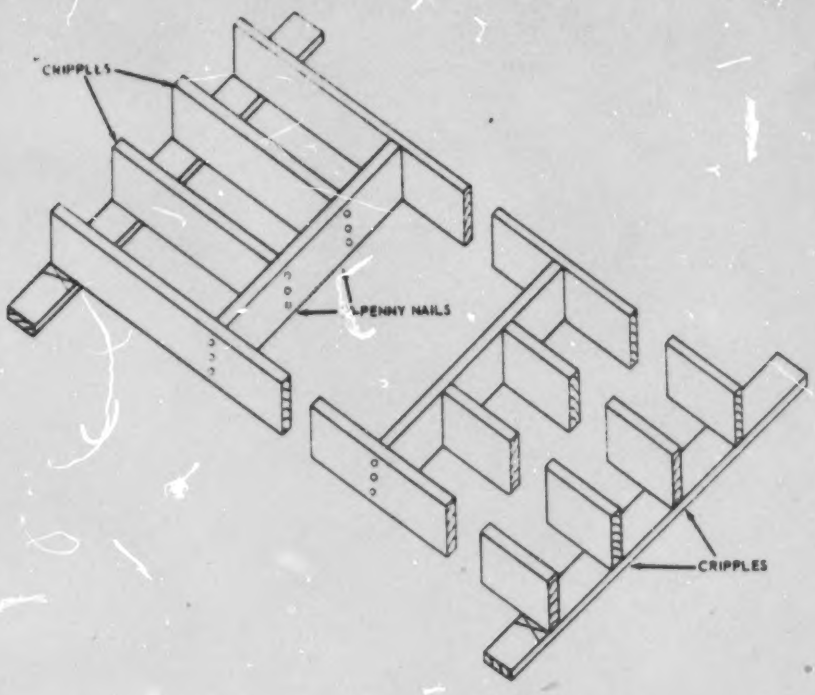
Figure 10-22.—Joist location layout—platform—frame box sill assembly with header joists.

A joist that butts against a header is plumbed by lining up the joist end with the perpendicular location line on the header. When the joist is in plumb position, it is nailed at the ends with 20-penny nails, 2 to each end, driven through the header into the joist.

After all the common joists, plus the inside trimmers (if there are any), have been plumbed and braced, the framing around a floor opening (if there is one) is installed. First the locations of the headers are determined from a study of the floor framing plan. Next the length of a header is determined by measurement of the shortest distance between the inside trimmers. The four pieces of joist stock which will form the double headers are then cut to correct length, after which the outside header of each pair is set in place and fastened to the inside trimmers with 20-penny nails, three to each end, driven through the trimmers into the ends of the headers as shown in figure 10-23.

Once the outside headers are in place, the lengths of the cripple joists can be determined by simple measurement. The cripples are cut, set in place, plumbed, fastened at the outer ends like common joists, and fastened at the floor-opening ends with 20-penny nails, three to each cripple, driven through the outside headers into the ends of the cripples as shown in figure 10-24.

Next the inside headers are set in place, fastened to the outside headers with 16-penny nails spaced 6-in. O.C., and fastened to the inside trimmers with 20-penny nails, three to



133.106

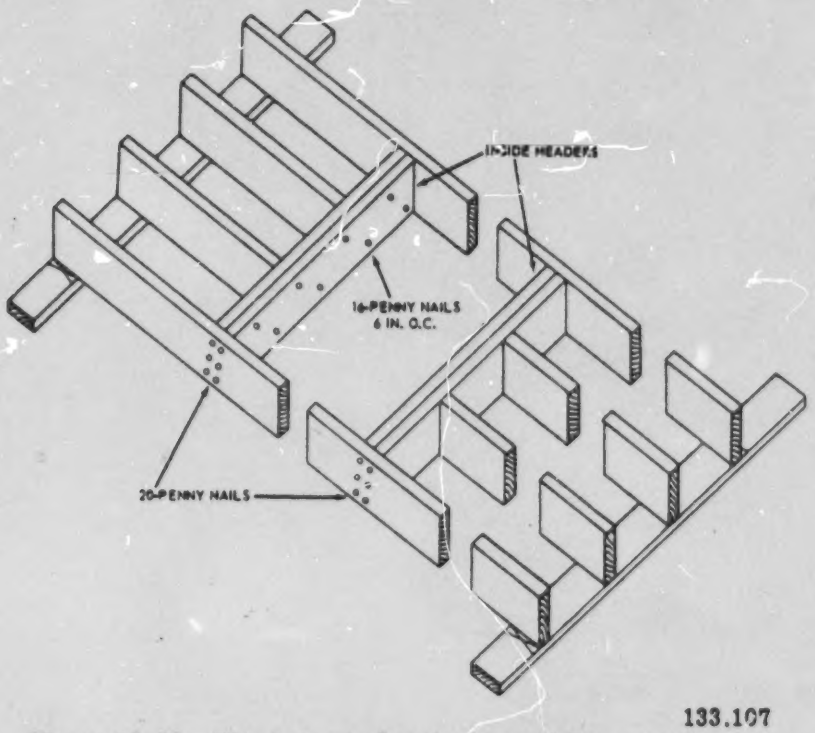
Figure 10-24.—Second step in framing around floor opening.

this triangle is the length of the line DE. From the roof triangle you know that the rise of a similar triangle with a run of 12 in. is 8 in. If the rise of a right triangle with a run of 12 in. is 8 in., the rise of a similar right triangle with a run of 16 in. must be the value of x in the proportional equation 12:8::16:x, or 10 2/3 in. The length of DE, therefore, is 10 2/3 in. Rounded off to the nearest 1/16 in., this is 10 11/16 in. The common difference may also be found as follows. Multiply the cut of the roof, expressed as a fraction, by the spacing of the studs. Assume a roof cut of 8 in. and 12 in. and a stud spacing of 16 in. The common difference in the length of the gable stud is 16 in. x 8/12 in. = 10 2/3 in. Expressed as a formula, stud spacing x cut of the roof = common difference.

If the rise of a right triangle for 16 in. of run is 10 11/16 in., the rise for twice as much run, or 32 in., must be twice as much, or 2 x 10 11/16 in.; the rise for three times as much run must be 3 x 10 11/16; and so on. This means that, moving inboard from the rafter plates, each gable-end stud is 10 11/16 in. longer than the preceding gable-end stud.

Knowing this, you can lay off the lengths of the gable-end studs by laying off 10 11/16 in. (which is called the COMMON DIFFERENCE of gable-end studs) progressively for each stud, from the shortest to the longest, in either side of the end wall. The top end cut of the gable stud is laid out by using the cut of the roof and marking on the rise side.

A pattern layout for platform-frame studs is shown in figure 10-28. Since the bottom of a platform-frame stud rests on the sole plate, which in turn rests on the subflooring, you should first lay off the vertical distance between the finish floors, MINUS the thickness of the sole plate, PLUS the thickness of the finish floor. This is distance 1 in figure 10-28; laying it off will give you the level of the upper finish floor. Lay off back from this level the combined thickness of the upper floor flooring, the depth of an upper floor joist, and the thickness of the top plate. You now have the length of a stud, as shown in the figure.



133.107

Figure 10-25.—Third step in framing around floor opening.

STUD LOCATION LAYOUT

Stud locations are marked on sole plates in the same manner as joist locations. The sole plate is marked first, as shown in figure 10-29. These marks are then transferred to the corresponding top plate or rafter plate, by "matching" the top plate or rafter plate against the marked sole plate and squaring the marks across.

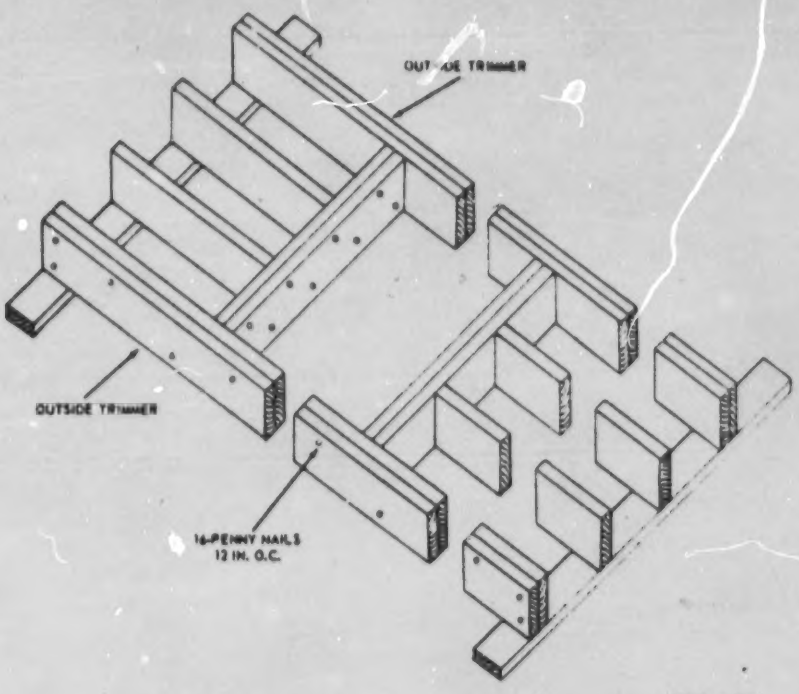
The studs around wall openings require special treatment. First locate the center line of the opening by examining the floor plan. Let's say that the opening is a door, and that the plan shows that the center line of this door lies 7 ft 5 in. from one of the building corners. Measure this off and square a line across the sill or plate at this point. Next look on the door schedule and find the width of this door. Let's say that it is Door A, and you find that Door A is 3 ft wide. Lay off one-half of this, or 1 ft 6 in., on either side of the center line and square lines across.

FRAMING ALLOWANCE

These lines mark the boundaries of the FINISHED door opening. The trimmer studs on either side of the opening, however, must be located at the boundaries of the ROUGH opening. To get the width of the rough opening you add a FRAMING ALLOWANCE to the width of the finished opening. First, the width of the rough opening must exceed the width of the finished opening by the combined thicknesses of the SIDE JAMBS on the door, less the combined width of the rabbets if the door fits into rabbets cut in the side jambs.

Besides the allowance for the thickness of the jambs, you must make an additional FRAMING ALLOWANCE. As you will see later, the side jambs are wedged in place with wooden wedges, driven between the jambs and the trimmers. The usual wedging allowance is 1/2 in. on either side.

The width of the finished opening (which is the same as the width of the door) is the



133.108

Figure 10-26.—Fourth step in framing around floor opening.

horizontal distance between the side jambs. The width of the rough opening is the same horizontal distance, plus the combined width of the jambs, plus the combined width of the wedging allowance.

To locate the trimmers, then, lay off, on either side of the center line, one-half the width of the door, plus the thickness of a side jamb (which should be measured on the actual stock), plus the wedging allowance (usually 1/4 in.). Mark the trimmer locations with the word TRIM, and postpone the cutting of the trimmers until after the header has been cut and set in place.

The header will be nailed between the first two full-length studs lying outside the boundaries of the finished opening. To locate the header at the right height you must add to the height of the door a framing allowance as follows. You must make allowance for the thickness of the head jamb, and also for the depth of the SIDE JAMB LUGS. The side jamb lugs are the portions of the side jambs which extend above the head jamb dadoes. Since you will be measuring from the top of the subflooring and since the bottom of the door will have to clear the finish flooring, you must allow for the thickness of the finish flooring. If there is to be a threshold under the door, you must allow for the thickness of the threshold. If there will be no threshold, you must add a CLEARANCE ALLOWANCE which will permit the door to swing clear of any rugs or carpets. The usual clearance allowance is 5/8 in., which is also the usual thickness of a threshold. If the carpeting is to be extra thick, the clearance allowance may have to be more than 5/8 in.

The framing allowance for a window opening is calculated as follows: locate and mark the window center line and lay off on either side of the center line one-half the width of the window, as obtained from the window schedule. This will locate the limits of the finished window opening. The top header and subsill header will be set between the first two full-length studs lying outside these limits.

Further window-opening layout should be postponed until the subsill header has been set

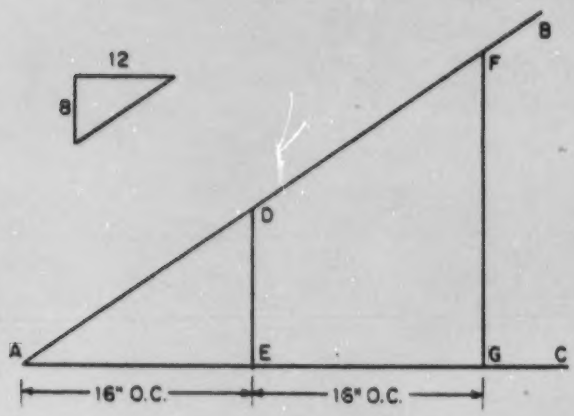


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Figure 10-27.—Calculating common difference of gable-end studs.

in place. The height of the subsill header is obtained as follows: determine by examining the appropriate elevation, the height of the top of the window sill above the finish flooring. Since you will be measuring from the subflooring, add the thickness of the finish flooring. From this, subtract the thickness of the window sill, plus the sill BEVEL ALLOWANCE, or amount that the sill will be raised by tilting. This is usually about 3/4". To sum up, the height of the top of the subsill header above the finish flooring will be the vertical distance between the top of the window sill and the top of the finish floor, MINUS the thickness of the window sill, the sill bevel allowance (usually 3/4 in.), and the thickness of the finish flooring.

The next step is to locate the top header at the proper height. On the elevation you will find the vertical distance between the finished first floor line and the bottom of the window head jamb. Since you will measure this distance from the top of the subfloor, add to it the thickness of the finish floor. Next add the thickness of the head jamb plus the depth of the window side jamb lugs, which are similar to those on a door. The total will be the vertical distance between the top of the subfloor and the bottom of the top header.

When you have located the level of the bottom of the top header, check the whole layout as follows. You know that the height of the rough opening should be the height of the window (as given on the schedule) plus the total framing allowance. Calculate the total framing allowance you have applied and add it to the window height. The result should be the same as the measured vertical distance between the top of the subsill header and the bottom of the top header. If it isn't, you have made a mistake somewhere.

To locate the trimmers proceed as follows: transfer the window center line to the subsill header and lay off on either side of it one-half the width of the window, as obtained from the window schedule. For a window without sash

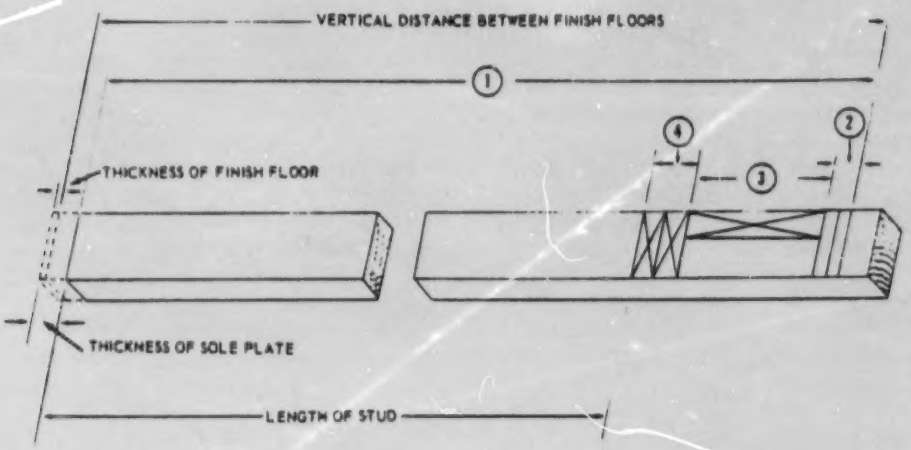

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Figure 10-28.—Pattern layout for platform-frame studs.

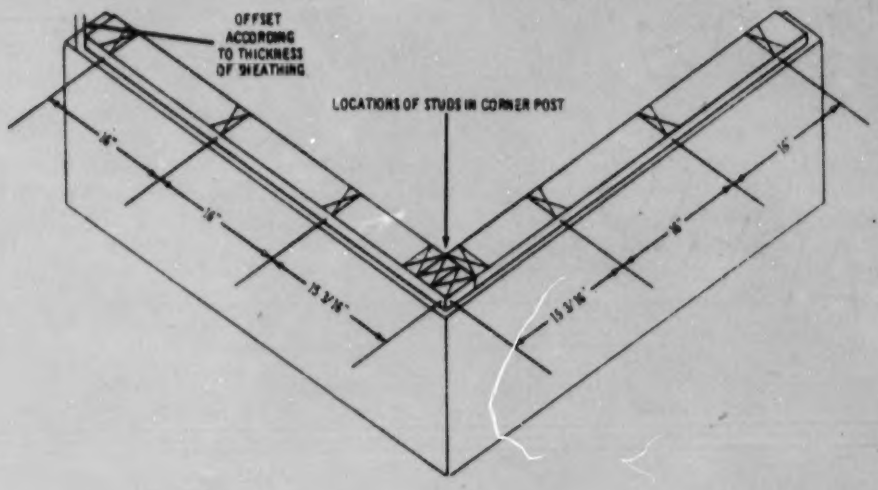

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Figure 10-29.—Stud location layout.

pockets, add on either side a framing allowance consisting of the thickness of the side jamb plus a wedging allowance of 1/2 in. If the window is a double hung window with sash weights, add the thickness of the side jamb plus 2 in. for the width of the sash pocket. These terms are explained in chapter 13.

WALL FRAMING ERECTION

The steps in erecting a frame wall are to erect and plumb each of the corner posts as follows. Set the post in exact position on the plate, and toenail it down with 8-penny nails, 2 to each stud in the corner post. Attach temporary braces at the top, and nail couple of short blocks to the subflooring at the approximate points where the ends of the braces will be fastened. Set nails in the floor ends of the braces, ready to be driven into the blocks when the exact position of each end is found.

While one man applies and reads the level, another man should be ready to nail the brace to the block as soon as correct position is found. This man works the end of the brace back and forth, on signal from the man at the level, until he gets the word that the bubble is centered. He then nails the end of the brace to the block. When this procedure has been followed with both braces, the corner post will be plumb all around.

Erection of the section of wall lying between the corner posts may be either by the PIECE-BY-PIECE method or by the SECTION method. In the piece-by-piece method, the wall is erected a piece at a time, meaning that each of the studs is raised and toenailed in place separately, after which the top plate or rafter plate is nailed on. In the section method the entire wall section, with the exception usually of the framing around openings and the upper member of the top plate or rafter plate, is assembled lying flat on the subflooring. The section is then heaved up into place and fastened at the top and bottom. Nowadays the section method is used for almost all platform-frame walls.

The full-length studs are laid out adjacent to their location marks on the sole plate. As previously mentioned, the lower member of the top plate or rafter plate has already been matched against the sole plate, and marked with the corresponding stud locations. After the full-length studs have all been laid out flat, the lower member of the top plate or rafter plate is nailed to the tops of the studs with 16-penny nails, 2 to each stud, driven through the plate into the studs.

The wall section is then heaved up into place and temporarily braced. The bottoms of the braces are only tacked to the floor blocks at this time, so that their positions can be adjusted later when the wall is straightened. Each of the

studs is toenailed down to its mark on the sole plate with 8-penny nails, 2 to each side of a stud. An adjoining wall section is then erected in the same manner, after which the upper members of the top plates or rafter plates are nailed to the lower members with 10-penny nails spaced 16 in. O.C. End-laps between adjoining plates are nailed down with 16-penny nails, 2 to each lap.

When all four walls have been erected, each wall is straightened as follows. A guide line is stretched between the tops of the corner posts, and the bottoms of the temporary braces are released from the floor blocks. Beginning at one end of the wall, each brace is adjusted so as to bring the outer edge of the top plate in exact contact with the line. The bottom of the brace is then again nailed to the floor block.

The next step is to frame the rough openings. The procedure for this is much the same as it is for framing a floor opening. Trimmers are nailed to full-length studs, or to each other, with 10-penny nails spaced 16 in. O.C. Headers are nailed to full-length studs with 8-penny nails, 2 to each end of a header member, driven through the full-length studs into the ends of the headers. Double headers are nailed to each other with 10-penny nails spaced 16 in. O.C.

Next step is to cut gains for diagonal bracing (if any) in studs and plates. Lay out these gains by placing the 1 x 6 bracing material in position against the framing members and scoring the outline on each stud or plate. Nail bracing on with two 8-penny nails to each stud or plate crossing.

WALL SHEATHING

The inner layer of outside wall covering on a frame structure is called the SHEATHING (usually pronounced "SHEETING"); the outer layer is called the SIDING. The siding, because it is not a structural element, is considered a part of the exterior finish. The sheathing, because it strengthens and braces the wall framing, is considered a structural element and therefore a part of the framing.

TYPES OF SHEATHING

The four most common types of sheathing used on modern structures are WOOD, PLYWOOD, FIBERBOARD, and GYPSUM.

WOOD sheathing consists usually of 1 x 6 or 1 x 8 boards, but thicker and/or wider stock is sometimes used. Boards may be square-edged for ordinary edge-butt joining, or they may be SHIPLAP or TONGUE AND GROOVE (fig. 10-30). "Dressed-and matched" is simply a term which is used instead of "tongue-and-groove" with reference to sheathing, siding, or flooring.

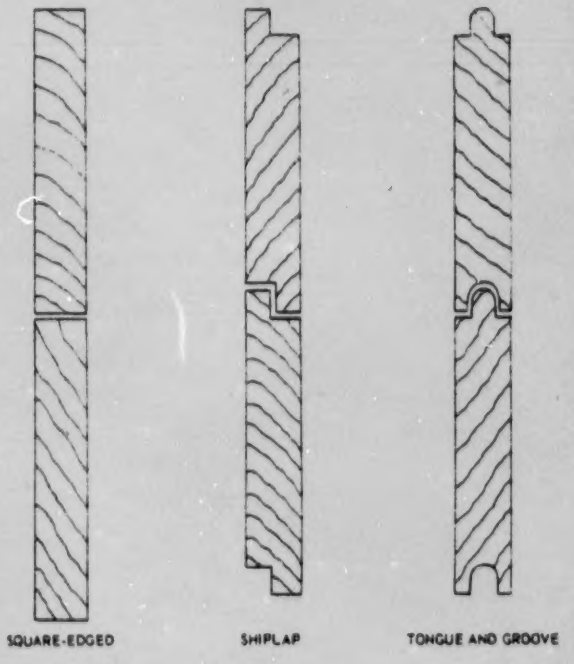

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Fig. 10-30.—Types of wood sheathing.

PLYWOOD sheathing is normally used in 4- by 8-ft sheets which are usually applied VERTICALLY, or with the 8-ft dimension vertical. The type of plywood used is called SHEATHING GRADE; for studs spaced 16 in. O.C. the minimum thickness is 5/16 in.

FIBERBOARD (sometimes called INSULATION BOARD) is a synthetic material which may be coated or impregnated with asphalt to increase water resistance. Edges are usually shiplap or tongue and groove for joining. Thickness is normally 25/32 in.

GYPSUM sheathing consists of a treated gypsum filler faced on both sides with a lightweight paper. Sheets are usually dressed-and-matched, with V-shaped grooves and tongues.

APPLICATION OF SHEATHING

As soon as all the wall openings have been framed, the application of the sheathing begins.

Wood wall sheathing can be obtained in almost all widths, lengths, and grades. Generally, widths are from 6 to 12 inches, with lengths selected for economical use. Almost all solid wood wall sheathing used is 13/16-inches thick and either square or matched edge. This material may be nailed on horizontally or diagonally (fig. 10-31). Diagonal application contributes much greater strength to the structure. Sheathing should be nailed on with three 8-penny common nails to each bearing if the pieces are over 6 inches wide. Wooden sheathing is laid on tight, with all joints made over the studs. If the sheathing is to be put on horizontally, it should be started at the foundation and worked toward the top. If it is to be put on diagonally, it should be started at the corners of the building and worked toward the center or middle of the building.

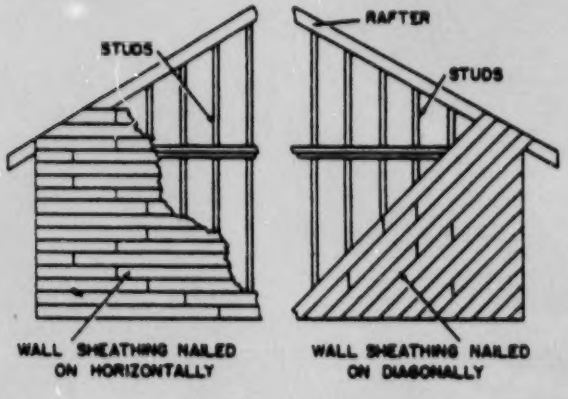

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Figure 10-31.—Diagonal and horizontal wooden sheathing.

Plywood as a wall sheathing (fig. 10-32) is highly recommended by its size, weight, stability, and structural properties, plus the ease and rapidity of application. It adds considerably more strength to the frame than does diagonally applied wood boards. When plywood sheathing is used, corner bracing can be omitted. Large size panels effect a major saving in the time required for application and still provide a tight, draft-free installation that contributes a high insulation value to the wall. Minimum thicknesses of plywood wall sheathing is 5/16-inch for 16-inch stud spacing and 3/8-inch for 24-inch stud spacing. The panels should be installed with the face grain parallel to the studs. However, a little more stiffness can be gained by installing them across the studs, but this requires more cutting and fitting. Use 6-penny common nails for 5/16-, 3/8-, and 1/2-inch panels and 8-penny common nails for 5/8- and 13/16-inch panels. Space the nails not more than 6 inches on center at the edges of the panels and not more than 12 inches on center elsewhere.

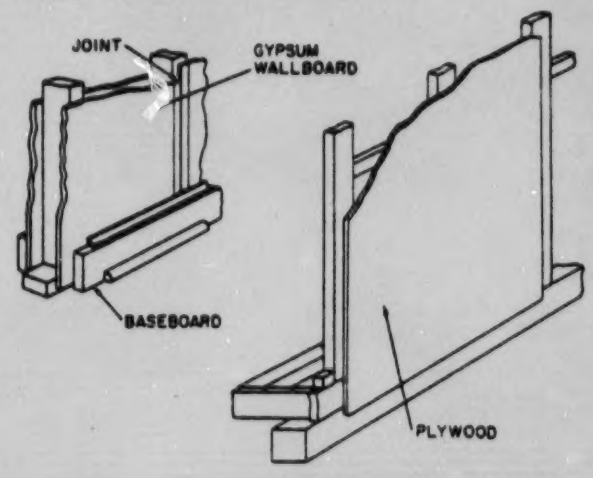

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Figure 10-32.—Gypsum and plywood sheathing.

Fiberboard sheets are applied vertically or horizontally. The material is nailed on with 2-in. galvanized roofing nails. A nail should be started at least 3/8 in. away from the edge of a sheet.

Gypsum-board sheathing (fig. 10-32) is made by casting a gypsum core within a heavy water-resistant fibrous envelope. The long edges of the 4 by 8 foot boards are tongued and grooved. Each board is a full 1/2-inch thick. Its use is mostly with wood siding that can be nailed directly through the sheathing and into the studs. Gypsum sheathing is fireproof, water resistant, and windproof; does not warp nor absorb water; and does not require the use of building papers.

CHAPTER 11
ROOF FRAMING

The use of concrete walls in Navy-built structures has increased in recent years, and the use of frame walls has decreased to a certain degree. The use of frame roofs has not decreased nearly as much, however. Many Navy-built concrete-walled structures are still being covered with wood-frame roofs.

ROOFS

The primary object of a roof in any climate is to keep out the rain and the cold. The roof must be sloped so as to shed water. Where heavy snows cover the roofs for long periods of time, roofs must be constructed more rigidly to bear the extra weight. They must also be strong enough to withstand high winds. The most commonly used types of roof construction include the gable, the lean-to or shed, the hip, and the gable and valley.

The GABLE roof (fig. 11-1) has two roof slopes meeting at the center, or ridge, to form a gable. This form of roof is the one most commonly used by the Navy, since it is simple in design, economical to construct, and may be used on any type structure.

LEAN-TO or SHED ROOF (fig. 11-1), is a near-flat roof and is used where large buildings are framed under one roof, where hasty or temporary construction is needed, and where sheds or additions to buildings are erected. The pitch of the roof is in one direction only. The roof is held up by the walls or posts on four sides; one wall or the posts on one side are at a higher level than those on the opposite side.

The HIP roof (fig. 11-1) consists of four sides or slopes running toward the center of the building. Rafters at the corners extend diagonally to meet at the center, or ridge. Into these rafters, other rafters are framed.

GABLE and VALLEY roof is a combination of two gable roofs intersecting each other. The valley is that part where the two roofs meet, each roof slanting in a different direction. This type of roof is slightly complicated and requires much time and labor to construct.

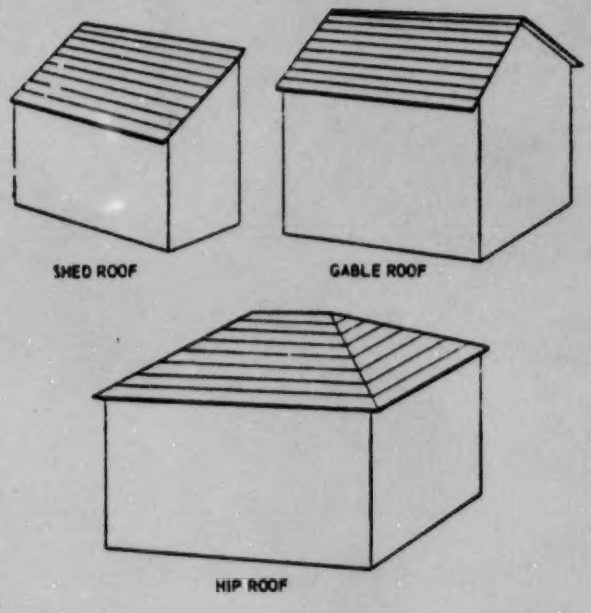

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Figure 11-1.—Most common types of pitched roofs.

TERMS USED IN ROOF CONSTRUCTION

The PITCH or "slope" of a roof is the angle which the roof surface makes with a horizontal plane. The surface may vary from absolutely flat to a steep slope. The usual way to express roof pitch is by means of numbers: for example, 8 and 12, 8 being the rise and 12 the run. On drawings, roof pitch is shown in figure 11-2.

The SPAN (part 1, fig. 11-3) of any roof is the shortest distance between the two opposite rafter seats. Seated in another way, it is the measurement between the outside plates, measured at right angles to the direction of the ridge of the building.

The TOTAL RISE (part 2, fig. 11-3) is the vertical distance from the plate to the top of the ridge.

The term "TOTAL RUN" (part 1, fig. 11-3) always refers to the level distance over which

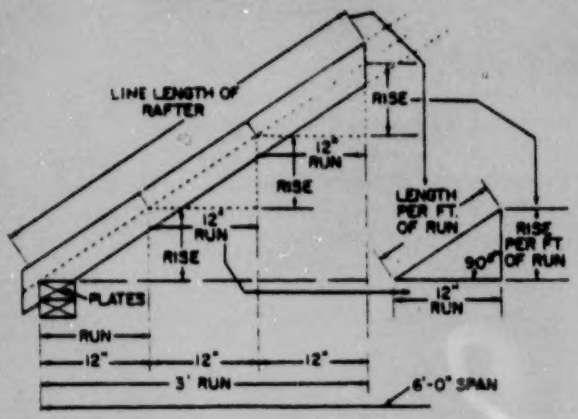

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Figure 11-2.—Roof pitch.

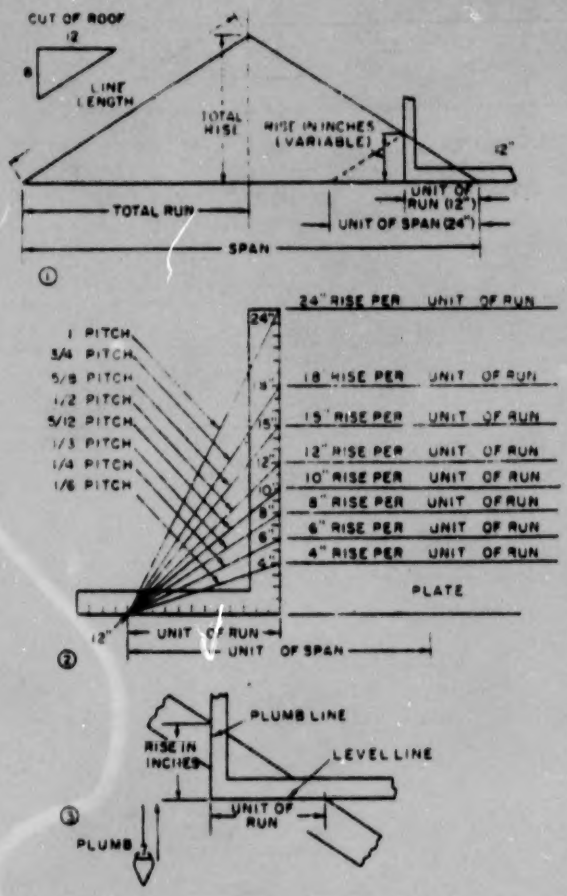

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Figure 11-3.—Roof terms.

any rafter passes. For the ordinary rafter, this would be one-half the span distance.

The unit of measurement or unit of run, 1 foot or 12 inches is the same for the roof as for any other part of the building. By the use of this common unit of measurement, the framing square is employed in laying out large roofs (parts 1 and 2, fig. 11-3).

The rise in inches is the number of inches that a roof rises for every foot of run.

The cut of a roof is the rise in inches and the unit of run (12 inches) (part 2, fig. 11-3).

The "line length" as applied to roof framing is the hypotenuse of a triangle whose base is the total run and whose altitude is the total rise (part 1, fig. 11-3).

PLUMB and LEVEL LINES refer to the direction of a line on a rafter and not to any particular rafter cut. Any line that is vertical when the rafter is in its proper position is called a plumbline. Any line that is level when the rafter is in its proper position is called a level line (part 3, fig. 11-3).

RAFTERS

The pieces which make up the main body of the framework of all roofs are called rafters. They do for the roof what the joists do for the floor and what the studs do for the wall. Rafters are inclined members spaced from 16 to 48 inches apart which vary in size, depending on their length and the distance at which they are spaced. The tops of the inclined rafters are fastened in one of the various common ways determined by the type of roof. The bottoms of the rafters rest on the plate member which provides a connecting link between wall and roof and is really a functional part of both. The structural relationship between rafters and wall is the same in all types of roofs. The rafters are not framed into the plate but are simply nailed to it, some being cut to fit the plate while others, in hasty construction, are merely laid on top of the plate and nailed in place. Rafters may extend a short distance beyond the wall to form the eaves and protect the sides of the building.

TERMS USED IN CONNECTION WITH RAFTERS

Since rafters, with ridgeboards and plates, are the principal members of roof framing, it

is important to understand the following terms that apply to them.

The COMMON rafters (part 1, fig. 11-4), extend from plate to ridgeboard at right angles to both.

HIP rafters (part 2, fig. 11-4), extend diagonally from the outside corners formed by perpendicular plates to the ridgeboard.

VALLEY rafters (part 3, fig. 11-4), extend from the plates to the ridgeboard along the lines where two roofs intersect.

JACK rafters never extend the full distance from plate to ridgeboard. Jack rafters are subdivided into the hip jacks (part 4, fig. 11-4), the lower ends of which rest on the plate and the upper ends against the hip rafter; valley

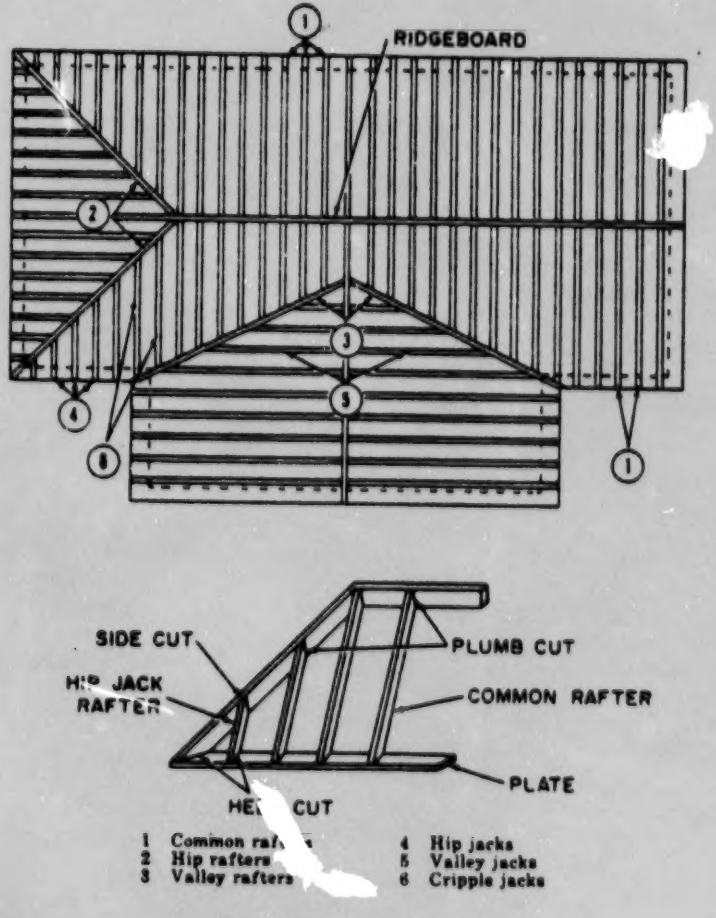

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Figure 11-4.—Rafter terms.

jacks (part 5, fig. 11-4), the lower ends of which rest against the valley rafters and the upper ends against the ridgeboard; and cripple jacks (part 6, fig. 11-4), which are nailed between hip and valley rafters.

TOP or PLUMB CUT is the cut made at the end of the rafter to be placed against the ridgeboard or, if the ridgeboard is omitted, against the opposite rafters.

SEAT, BOTTOM, or HEEL CUT is the cut made at the end of the rafter which is to rest on the plate.

SIDE or CHEEK CUT is a bevel cut on the side of a rafter to fit it against another frame member.

RAFTER LENGTH is the shortest distance between the outer edge of the plate and the center of the ridge line.

EAVE or TAIL is the portion of the rafter extending beyond the outer edge of the plate.

MEASURE LINE is an imaginary reference line laid out down the middle of the face of a rafter. If a portion of a roof is represented by a right triangle (fig. 11-5), the measure line will correspond to the hypotenuse, the rise to the leg, and the run to the base.

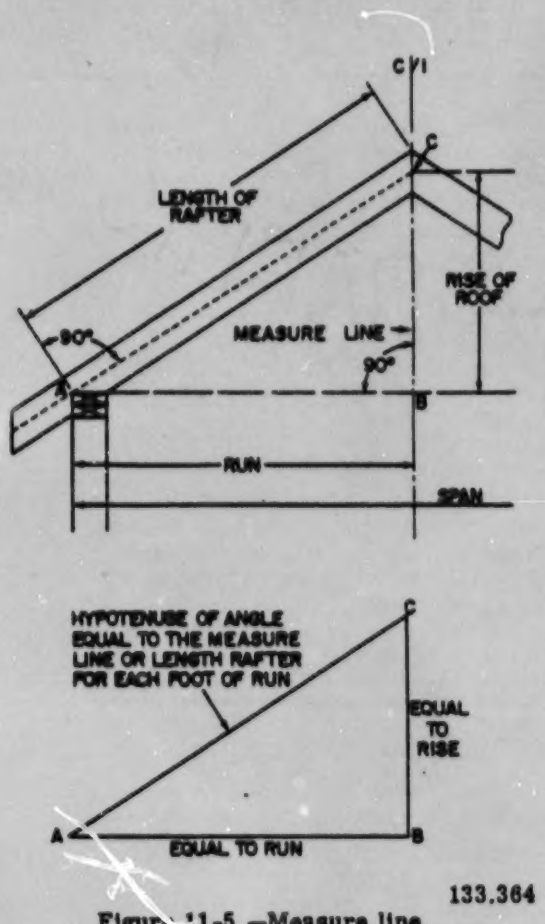

Figure 11-5.—Measure line.

COMMON RAFTER LAYOUT

Rafters must be laid out and cut with slope, length, and overhang exactly right so that they will fit when placed in the position they are to occupy in the finished roof.

The Builder first determines the length of the rafter and the length of the piece of lumber from which the rafter may be cut. If he is working from a set of plans which includes a roof plan, the rafter lengths and the width of the building may be obtained from this plan. If no plans are available, the width of the building may be measured with a tape. To determine the rafter length, first find one-half of the distance between the outside plates. This distance is the horizontal distance which the rafter will cover. The amount of rise per foot has yet to be considered. If the building to be roofed is 20 feet wide, half the span will be 10 feet. For example, the rise per foot is to be 8 inches. To determine the approximate overall length of a rafter, measure on the steel carpenter square the distance between 8 on the tongue and 12 on the blade, because 8 is the rise and 12 is the unit of run. This distance is 14 5/12 inches, and represents the line length of a rafter with a total run of 1 foot and a rise of 8 inches. Since the run of the rafter is 10 feet, multiply 10 by the line length for 1 foot. The answer is 144 2/12 inches, or 12 feet and 1/6 inch. The amount of overhang, normally 1 foot, must be added if an overhang is to be used. This makes a total of 13 feet for the length of the rafter, but since 13 feet is an odd length for timber, a 14-foot timber is used.

After the length has been determined, the timber is laid on sawhorses, sometimes called "saw benches," with the crown or bow (if any) as the top side of the rafter. If possible, select a straight piece for the pattern rafter. If a straight piece is not available, have the crown toward the person laying off the rafter. Hold the square with the tongue in the right hand, the blade in the left, the heel away from the body, and place the square as near the upper end of

the rafter as possible. In this case, the figure 8 on the tongue and 12 on the blade are placed along the edge of timber which is to be the top edge of the rafter as shown in view 1, figure 11-6. Mark along the tongue edge of the square, which will be the plumb cut at the ridge. Since the length of the rafter is known to be 12 feet and 1/6 inch, measure the distance from the top of the plumb cut and mark it on the timber. Hold the square in the same manner with the 8 mark on the tongue directly over the 12-foot and 1/6 inch mark. Mark along the tongue of the square to give the plumb cut for the seat (view 2, fig. 11-6). Next measure off, perpendicular to this mark, the length of overhang along the timber and make a plumb cut mark in the same manner, keeping the square on the same edge of the timber (view 3, fig. 11-6). This will be the tail cut of the rafter; often the tail cut is made square across the timber.

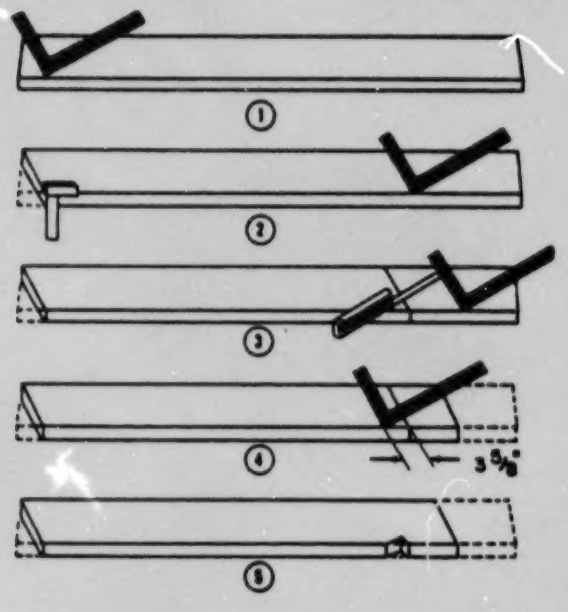

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Figure 11-6.—Rafter layout—scale or measurement method.

The level cut or width of the seat is the width of the plate, measured perpendicular to the plumb cut, as shown in view 4, figure 11-6. Using the try square, square lines down on the sides from all level and plumb cut lines. Now the rafter is ready to be cut.

If a building is 20 feet 8 inches wide, the run of the rafter would be 10 feet 4 inches, or half the span. Instead of using the above method, the rafter length may be determined by "stepping it off" by successive steps with the square as shown in figure 11-7. Stake the same number of steps as there are feet in the run, which leaves 4 inches over a foot. This 4 inches is taken care of in the same manner as the full foot run; that is, with the square at the last step position, make a mark on the rafters at the 4-inch mark on the blade, then move the square along the rafter until the tongue rests at the 4-inch mark. With the square held for the same cut as before, make a mark along the tongue. This is the line length of the rafter. The seat-cut and hangover are made as described above. When laying off rafters by any method, be sure to recheck the work carefully. When two rafters have been cut, it is best to put them in place to see if they fit. Minor adjustments may be made at this time without serious damage or waste of material.

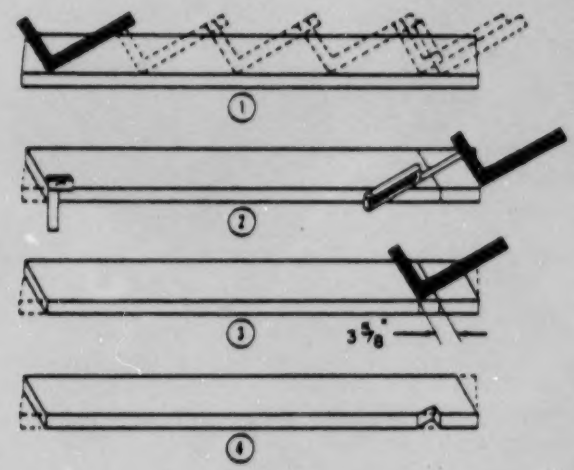

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Figure 11-7.—Rafter layout—step-off method.

TABLE METHOD, USING RAFTER TABLE ON FRAMING SQUARE

The rafter table which is located on the blade gives both the line length of any pitch or rafter per foot of run and the line length of any hip or valley rafter per foot of run. The difference in length of the jack rafter spaced 16 or 24 inches (on center) is also shown in the

table. Where the jack rafter, hip, or valley rafter requires side cuts, the cut is given in the table.

The table (fig. 11-8) appears on the face of the blade. It is used to determine the length of the common, valley, hip, and jack rafters, and the angles at which they must be cut to fit at the ridge and plate. To use the table, the Builder first must become familiar with it and know what each figure represents. The row of figures in the first line represents the length of common rafters per foot of run, as the title indicates at the lefthand end of the blade. Each set of figures under each inch division mark represents the length of rafter per foot of run with a rise corresponding to the number of inches over the number. For example, under the 16-inch mark appears the number 20.00 inches. This number equals the length of a rafter with a run of 12 inches and a rise of 16 inches, or, under the 13-inch mark appears the number 17.69 inches which is the rafter length for a 12-inch run and a 13-inch rise. The other five lines of figures in the table will not be discussed as they are seldom used.

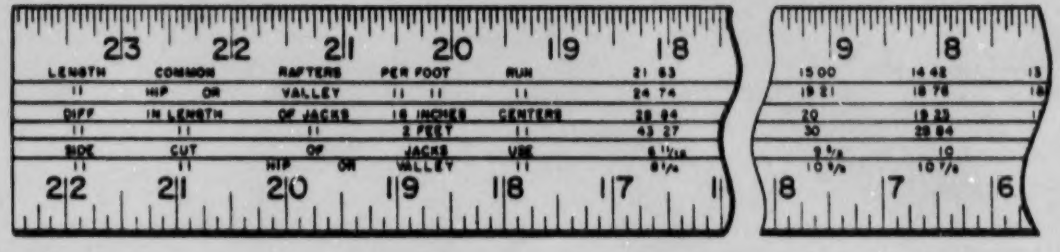
out the rafters after the length has been determined was described above.

When the roof has an overhang the rafter is usually cut square to save time. When the roof has no overhang, the rafter cut is plumb, but no notch is cut in the rafter for a seat. The level cut is made long enough to extend across the plate and the wall sheathing. This type of rafter saves material, although little protection is given to the side wall.

BIRD'S MOUTH

A rafter with a projection has a notch in it called a BIRD'S MOUTH, as shown in figure 11-9. The plumb cut of the bird's mouth, which bears against the side of the rafter plate is called the HEEL cut; the level cut, which bears on the top of the rafter plate, is called the SEAT cut.

The size of the bird's mouth is usually stated in terms of the depth of the heel cut rather than in terms of the width of the seat cut. You lay out the bird's mouth in about the same way you lay out the seat on a rafter without a projection.

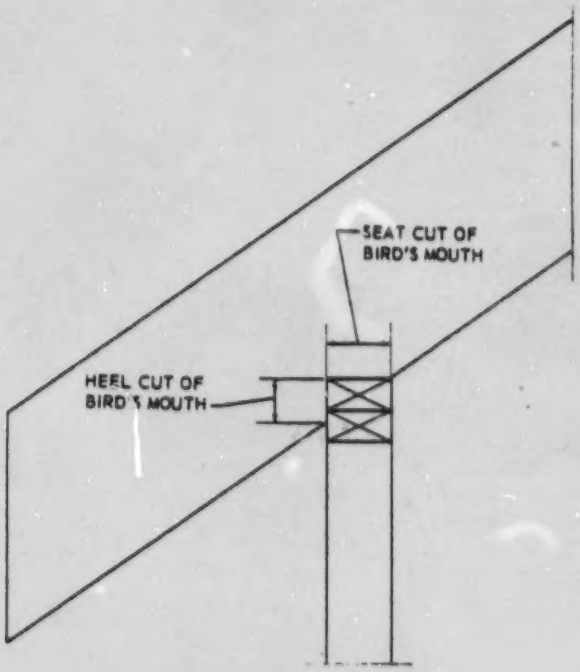

LENGTH COMMON RAFTERS PER FOOT RUN
HIP OR VALLEY
DIFF IN LENGTH OF JACKS 16 INCHES CENTERS
2 FEET
SIDE CUT OF JACKS USE
HIP OR VALLEY

133.367

Figure 11-8.—Rafter table method.

To use the table for laying out rafters, the width of the building must first be known. Suppose the building is 20 feet 8 inches wide and the rise of the rafters is to be 8 inches per foot of run. The total run of the rafter will be 10 feet 4 inches. Look in the first line of figures, under the 8-inch mark appears the number 14.42, which is the length in inches of a rafter with a run of 1 foot and a rise of 8 inches. To find the line length of a rafter with a total run of 10 feet 4 inches, multiply 14.42 inches by 10 1/3 and divide by 12 so as to get the answer in feet. The 14.42 inches by 10 1/3 equals 149.007 inches, which is divided by 12 to equal 12 5/12 feet. Therefore 12 feet 5 inches is the line length of the rafter. The remaining procedure for laying

Measure off the depth of the heel on the heel plumb line, set the square as shown in figure 11-10, and draw the seat line along the blade. For the roof surface, ALL RAFTERS should be exact, therefore, the amount above the seat cut, rather than the bottom edge of the rafters, is the most important measurement. Suppose that on a hip roof, or an intersecting roof, the hips or valley rafters are 2 x 6 and the common rafters 2 x 4. The amount above the seat cut should be such as to adequately support the overhang of the roof, plus personnel working on the roof. The width of the seat cut is important as a bearing surface. The maximum width of the common rafter should not exceed the width of the plate.



133:119

Figure 11-9.—Bird's mouth on a rafter with projection.

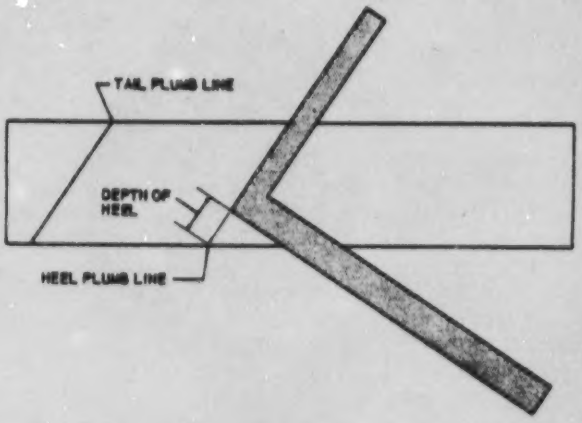
HIP RAFTER LAYOUT

Most hip roofs are EQUAL-PITCH hip roofs, in which the angle of slope on the roof end or ends is the same as the angle of slope on the sides. Unequal-pitch hip roofs do exist, but they are quite rare, and they require special layout methods. The UNIT LENGTH RAFTER TABLE on the framing square applies only to equal-pitch hip roofs.

In the following discussion of hip roof framing it will be assumed that in every case the roof is an equal-pitch hip roof.

The length of a hip rafter, like the length of a common rafter, is calculated on the basis of bridge measure times the unit of run. Any of the methods previously described for a common rafter may be used. Some of the basic data for a hip rafter, however, are different.

Take a look at figure 11-11, which shows part of a ROOF FRAMING DIAGRAM for an EQUAL-PITCH hip roof. A roof framing diagram may be included among the working drawings; if it is not, you should lay one out for yourself. Lay the building lines out to scale



133.120

Figure 11-10.—Laying out a bird's mouth.

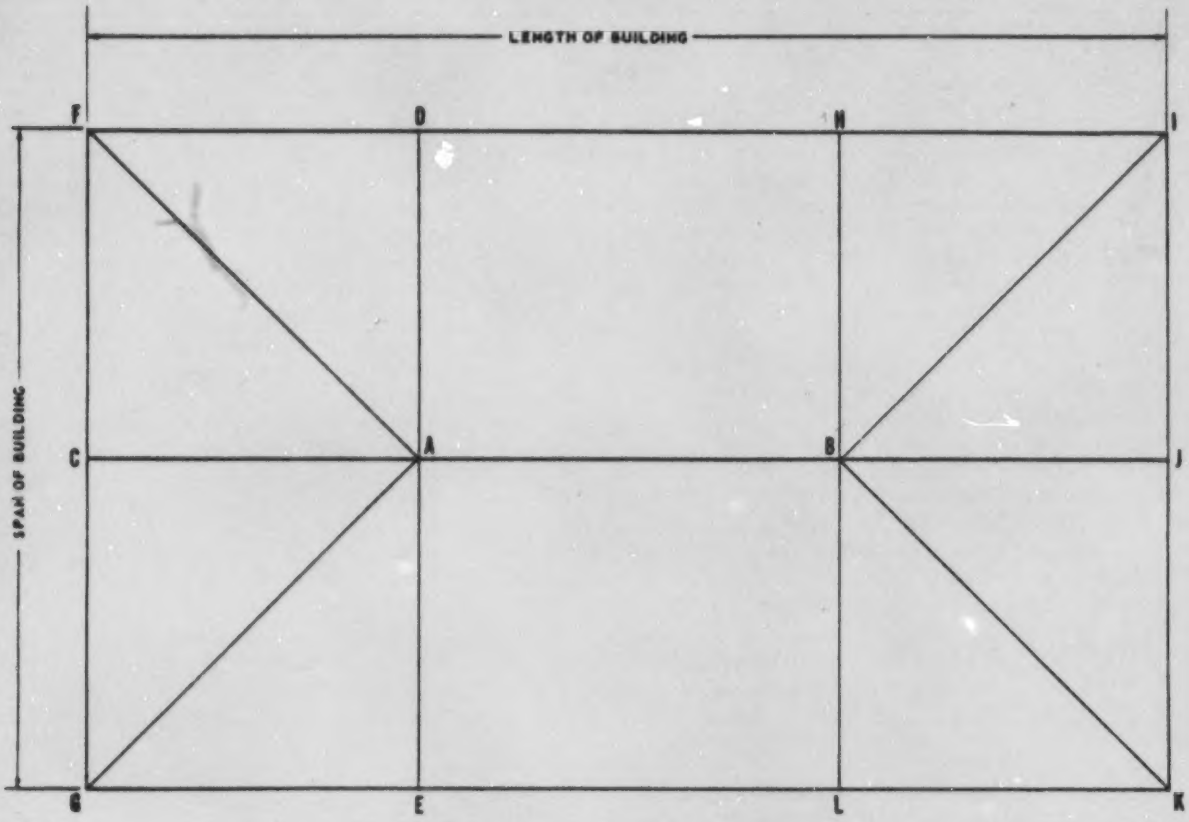
first; you can find the span and the length of the building on the working drawings. Then draw a horizontal line along the center of the span.

In an equal-pitch hip roof framing diagram the lines which indicate the hip rafters (FA, GA, IB, and KB in fig. 11-11) forms 45° angles with the building lines. Draw these lines in at 45°, as shown. The points where they meet the center line are the THEORETICAL ends of the ridge piece. The ridge-end common rafters CA, DA, EA, HB, JB, and LB join the ridge at the same points.

A line which indicates a rafter in the roof framing diagram is equal in length (to scale, of course) to the TOTAL RUN of the rafter it represents. You can see from the diagram that the total run of a hip rafter (represented by lines FA, GA, IB, and KB) is the hypotenuse of a right triangle with shorter sides each equal to the total run of a common rafter. You know the total run of a common rafter: it is one-half the span, or one-half the width of the building. Knowing this, you can find the total run of a hip rafter by applying the Pythagorean theorem.

Let us suppose, for example, that the span of the building is 30 ft. Then one-half the span, which is the same as the total run of a common rafter, is 15 ft. By the Pythagorean theorem, the total run of a hip rafter is the square root of $(15^2 + 15^2)$, or 21.21 ft.

What is the total rise? Since a hip rafter joins the ridge at the same height as a common rafter, the total rise for a hip rafter is the same as the total rise for a common rafter.



133.121

Figure 11-11.—Equal pitch hip roof framing diagram.

You know how to figure the total rise of a common rafter. Let us support that this roof has a unit run of 12 and a unit rise of 8. Since the total run of a common rafter in the roof is 15 ft, the total rise of a common rafter is the value of x in the proportional equation 12:8::15:x, or 10 ft.

Knowing the total run of the hip rafter (21.21 ft) and the total rise (10 ft), you can figure the line length by applying the Pythagorean theorem. The line length is the square root of $(21.21^2 + 10^2)$, or 23.44 ft, or about 23 ft 5 1/4 in.

To find the length of a hip rafter on the basis of bridge measure, you must first determine the bridge measure. As with a common rafter, the bridge measure of a hip rafter is the length of the hypotenuse of a triangle with shorter sides equal to the unit run and unit rise of the rafter. The unit rise of a hip rafter is always the same as that of a common rafter, but THE UNIT RUN OF A HIP RAFTER IS DIFFERENT.

The unit run of a hip rafter in an equal-pitch hip roof is the hypotenuse of a right triangle with shorter sides each equal to the unit run of a common rafter. Since the unit run of a common rafter is 12, the unit run of a hip rafter is the square root of $(12^2 + 12^2)$, or 16.97.

If the unit run of the hip rafter is 16.97 and the unit rise (in this particular case) is 8, the unit length of the hip rafter must be the square root of $(16.97^2 + 8^2)$, or 18.76. This means that for every 16.07 units of run the rafter has 18.76 units of length. Since the total run of the rafter is 21.21 ft, the length of the rafter must be the value of x in the proportional equation 16.97:18.76::21.21:x, or 23.44 ft.

Like the unit length of a common rafter, the bridge measure of a hip rafter may be obtained

from the unit length rafter table on the framing square. If you turn back to figure 11-8, you will see that the second line in the table is headed "Length hip or valley rafters per foot run." This means "per foot run of A COMMON RAFTER IN THE SAME ROOF." Actually, the unit length given in the tables is the unit length for every 16.97 units of run OF THE HIP RAFTER ITSELF. If you run across to the unit length given under 8, you will find the same figure, 18.76 units, that you calculated above.

An easy way to calculate the length of an equal-pitch hip roof rafter is to multiply the bridge measure by the number of feet in the total run of a common rafter, which is the same as the number of feet in one-half of the span of the building. One-half of the span of the building in this case is 15 ft: the length of the hip rafter is therefore 18.76 x 15, or 281.40 in., which is 281.40/12, or 23.45 ft. Note that when you use this method you get a result in inches, which you must convert to feet. The slight difference of 0.01 ft between this result and the one previously obtained amounts to less than 1/8 in., and may be ignored.

You step off the length of an equal-pitch hip roof rafter just as you do the length of a common rafter, except for the fact that you set the square to a unit of run of 16.97 in. instead of to a unit of run of 12 in. Since 16.97 inches is the same as 16 in. and 15.52 sixteenths of an inch, setting the square to a unit of run of 17 in. is close enough for most practical purposes. Bear in mind that for any plumb cut line on an equal-pitch hip roof rafter you set the square to the unit rise of a common rafter and to a unit run of 17.

You step off the same number of times as there are feet in the total run of a common rafter in the same roof; only the size of each step is different. For every 12-in. step in a common rafter a hip rafter has a 17-in. step. In the roof on which we are working, the total run of a common rafter is exactly 15 ft; this means that you would step off the hip-rafter cut (17 in. and 8 in.) exactly 15 times.

Suppose, however, that there was an ODD UNIT in the common rafter total run. Assume, for example, that the total run of a common rafter is 15 ft 10 1/2 in. How would you make the odd fraction of a step on the hip rafter?

You remember that the unit run of a hip rafter is the hypotenuse of a right triangle with other sides each equal to the unit run of a common rafter. This being the case, the run of the odd unit on the hip rafter must be the hypotenuse of a right triangle with other sides each equal to the odd unit of run of the common rafter, which in this case is 10 1/2 in. You can figure this by the Pythagorean theorem (square root of $(10.5^2 + 10.5^2)$), or you can set the square on a true edge to 10 1/2 in. on the tongue and 10 1/2 in. on the blade and measure the distance between the marks. It comes to 14.84 in., which rounded off to the nearest 1/16 in. equals 14 13/16 in.

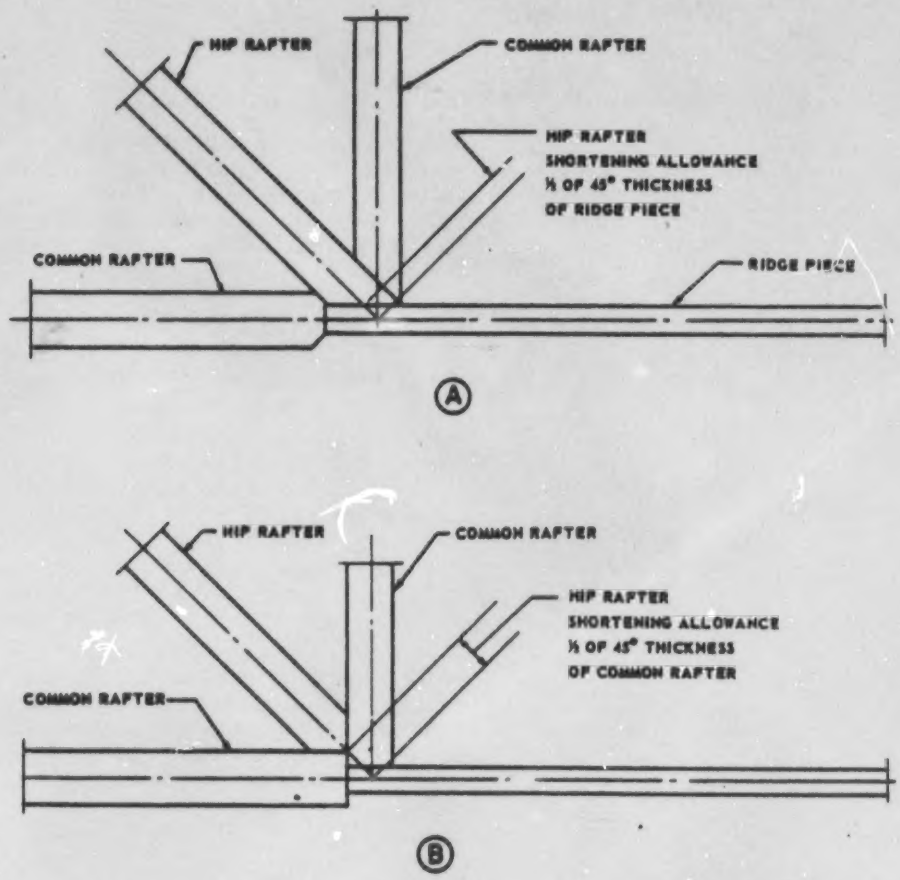
To lay off the odd unit, set the tongue of the framing square to the plumb line for the last full step made and measure off 14 13/16 in. along the blade. Place the tongue of the square at the mark, set the square to the hip rafter plumb cut of 8 in. on the tongue and 17 in. on the blade, and draw the line length cut line.

Hip Rafter Shortening Allowance

As is the case with a common rafter, the line length of a hip rafter does not take into account the thickness of the ridge piece. The size of the ridge-end shortening allowance for a hip rafter depends upon the manner in which the ridge end of the hip rafter is joined to the other structural members. As shown in figure 11-12, the ridge end of the hip rafter may be framed against the ridge piece (view A, fig. 11-12) or against the ridge-end common rafters (view B, fig. 11-12). If the hip rafter is framed against the ridge piece, the shortening allowance is one-half of the 45° thickness of the ridge piece. The 45° thickness of stock is the length of a line laid at 45° across the thickness dimension of the stock. If the hip rafter is framed against the common rafters, the shortening allowance is one-half of the 45° thickness of a common rafter. To lay off the shortening allowance, set the tongue of the framing square to the line length ridge cut line, measure off the shortening allowance along the blade, set the square at the mark to the cut of the rafter (8 in. and 17 in.), and draw the actual ridge plumb cut line.

Hip Rafter Projection

A hip rafter projection, like a common rafter, is figured as a separate problem. The run of a hip rafter projection, however, is not the same as the run of a common rafter projection in the same roof. Figure 11-13 shows you why. The run of the hip rafter projection,



133.122

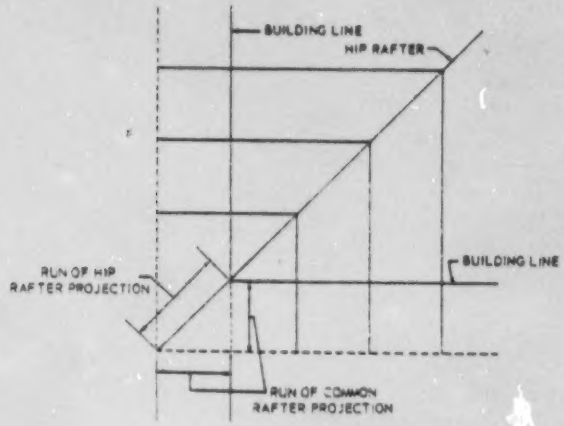
Figure 11-12.—Hip rafter shortening allowance.

as you can see, the hypotenuse of a right triangle with shorter sides each equal to the run of a common rafter projection. If the run of the common rafter overhang is 18 in., the run of the hip rafter is the square root of $(18^2 + 18^2)$, or 25.45 in. Since the rafter rises 8 units for every 17 units of run, the total rise of the projection is the value of x in the proportional equation 17:8::25.45:x, or 11.9 in. If the total run is 25.45 in. and the total rise 11.9 in., the length of the projection is the square root of $(25.45^2 + 11.9^2)$, or about 28 in.

Hip Rafter Side Cuts

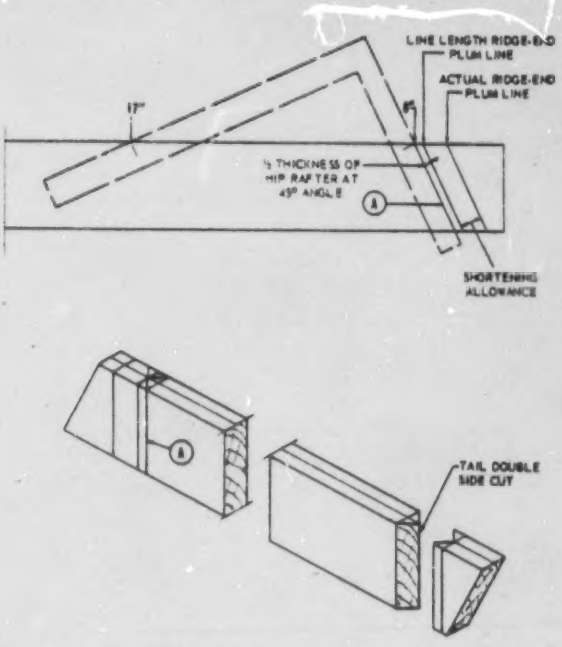
Since a common rafter runs at 90° to the ridge, the ridge end of a common rafter is cut square, or at 90° to the lengthwise line of the rafter. A hip rafter, however, joins the ridge, or the ridge ends of the common rafters, at an angle, and the ridge end of a hip rafter must therefore be cut to a corresponding angle, called a SIDE CUT. The angle of the side cut is more acute for a high unit rise than it is for a low one.

The angle of the side cut is laid out as shown in figure 11-14. Place the tongue of the framing square along the ridge cut line, as shown, and measure off one-half the thickness of the hip rafter along the blade. Shift the tongue to the mark, set the square to the cut of the rafter (17 in. and 8 in.), and draw the plumb line marked A in the figure. Then turn the rafter edge-up, draw an edge center line, and draw in the angle of the side cut as indicated in the lower view of figure 11-14. For a hip rafter



133.123

Figure 11-13.—Run of hip rafter projection.



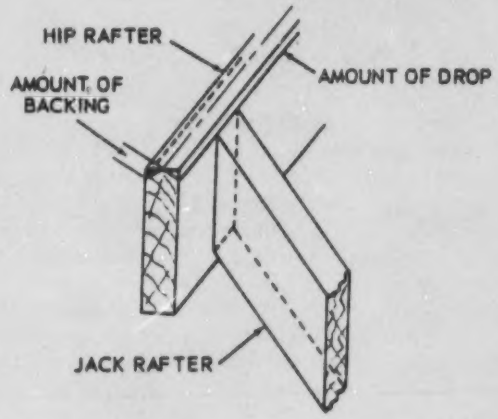
133.124

Figure 11-14.—Laying out hip rafter side cut.

which is to be framed against the ridge there will be only a single side cut, as indicated by the dotted line; for one which is to be framed against the ridge ends of the common rafters there will be a double side cut, as shown. The tail of the rafter must have a double side cut at the same angle, but in the reverse direction.

The angle of the side cut on a hip rafter may also be laid out by referring to the unit length rafter table on the framing square. If you turn back to figure 11-8, you will see that the bottom line in the table is headed "Side cut hip or valley use." If you follow this line over to the column headed by the figure 8 (for a unit rise of 8), you will find the figure 10 7/8. If you place the framing square face-up on the rafter edge, with the tongue on the ridge-end cut line, and set the square to a cut of 10 7/8 in. on the blade and 12 in. on the tongue, you can draw the correct side-cut angle along the tongue.

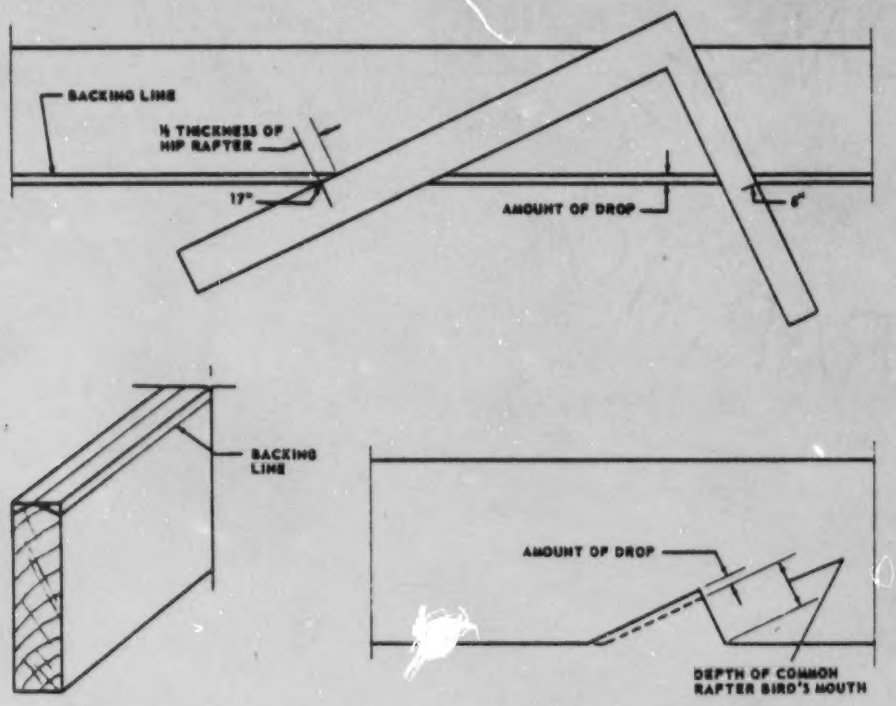
If the bird's mouth on a hip rafter had the same depth as the bird's mouth on a common rafter, the edges of the hip rafter would extend above the upper ends of the jack rafters as shown in figure 11-15. This can be corrected by either BACKING or DROPPING the hip rafter. Backing means to bevel the upper edge of the hip rafter. As shown in figure 11-15, the amount of backing is taken at the right angle to the roof surface, or the top edge of the hip rafter. Dropping means to deepen the bird's mouth so as to bring the top edge of the hip rafter down to the upper ends of the jacks. The amount of drop is taken on the heel plumb line.



133.125

Figure 11-15.—Backing or dropping a hip rafter.

The amount of backing or drop required is calculated as shown in figure 11-16. Set the framing square to the cut of the rafter (8 in. and 17 in.) on the upper edge, and measure off one-half the thickness of the rafter from the edge along the blade. A line drawn through this



133.126

Figure 11-16.—Determining required amount of backing or drop.

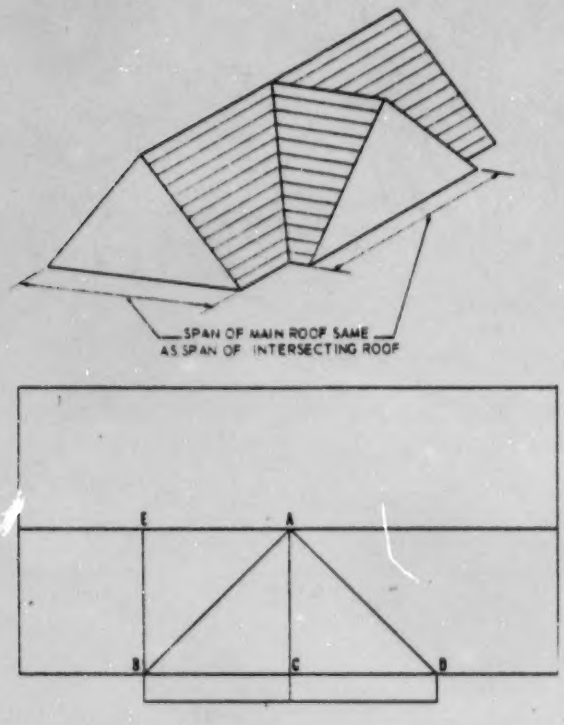
mark, parallel to the edge, will indicate the bevel angle, as shown, if the rafter is to be backed. The perpendicular distance between the line and the edge of the rafter will be the amount of drop—meaning the amount that the depth of the hip rafter bird's mouth should exceed the depth of the common rafter bird's mouth.

VALLEY RAFTER LAYOUT

A valley rafter follows the line of intersection between a main roof surface and a gable-roof addition or a gable-roof dormer surface. Most roofs which contain valley rafters are EQUAL-PITCH roofs, in which the pitch of the addition or dormer roof is the same as the pitch of the main roof. There are UNEQUAL-PITCH valley-rafter roofs, but they are quite rare, and they require special framing methods. In the discussion of valley rafter layout it will be assumed that the roof is in every case an equal pitch roof, in which the unit of run and unit of rise of the addition or dormer common rafter is the same as the unit of run and unit of rise of a main roof common rafter. In an equal-pitch roof the valley rafters always run at 45° to the building lines and the ridge pieces.

Figure 11-17 shows an EQUAL-SPAN framing situation, in which the span of the addition is the same as the span of the main roof. Since the pitch of the addition roof is the same as the pitch of the main roof, equal spans bring the ridge pieces to equal heights.

If you look at the roof framing diagram in the figure, you will see that the total run of a valley rafter (indicated by AB and AD in the diagram) is the hypotenuse of a right triangle with shorter sides equal to the total run of a common rafter in the main roof. The unit run of a valley rafter is therefore 16.97, the same as the unit run for a hip rafter. It follows that figuring the length of an equal-span valley rafter is the same as figuring the length of an equal-pitch hip roof hip rafter.



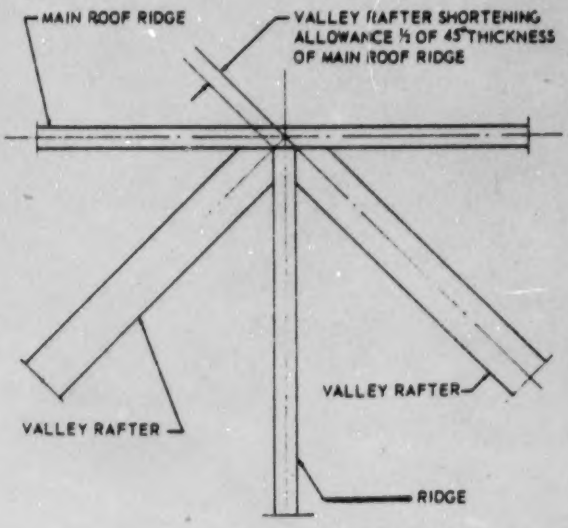
133.127

Figure 11-17.—Equal span main roof and intersection roof.

A valley rafter, however, does not require backing or dropping. The projection, if any, is figured just as it is for a hip rafter. Side cuts are laid out as they are for a hip rafter; the valley-rafter tail has a double side cut, like the hip-rafter tail, but in the reverse direction, since the tail cut on a valley rafter must form an inside rather than an outside corner. As indicated in figure 11-18 the ridge-end shortening allowance in this framing situation amounts to one-half of the 45° thickness of the ridge.

Figure 11-19 shows a framing situation in which the span of the addition is shorter than the span of the main roof. Since the pitch of the addition roof is the same as the pitch of the main roof, the shorter span of the addition brings the addition ridge down to a lower level than that of the main roof ridge.

There are two ways of framing an intersection of this type. By the method shown in figure 11-19, a full-length valley rafter (AD in the figure) is framed between the rafter plate and the ridge piece, and a shorter valley rafter

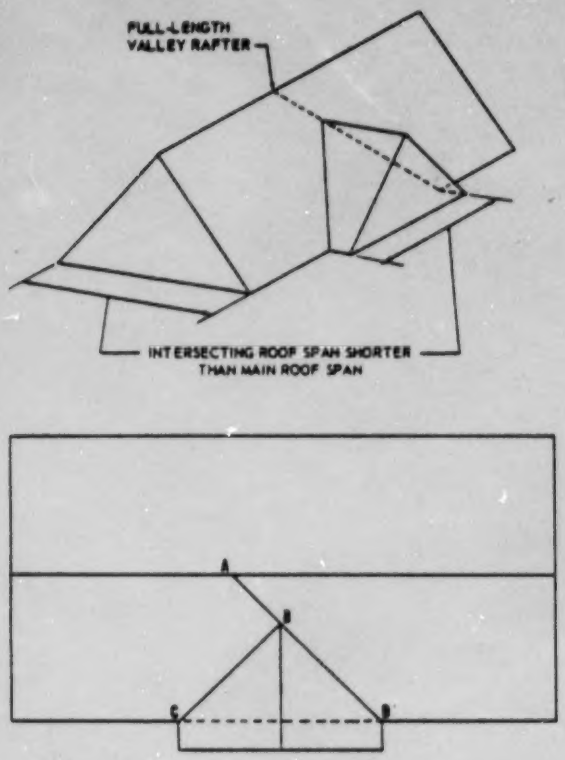

MAIN ROOF RIDGE
VALLEY RAFTER SHORTENING ALLOWANCE ½ OF 45° THICKNESS OF MAIN ROOF RIDGE
VALLEY RAFTER
VALLEY RAFTER
RIDGE

133.128

Figure 11-18.—Ridge-end shortening allowance for equal span intersection valley rafter.

(CB in the figure) is then framed to the longer one. If you study the framing diagram you will see that the total run of the longer valley rafter is the hypotenuse of a right triangle with shorter sides each equal to the total run of a common rafter IN THE MAIN ROOF. The total run of the shorter valley rafter, on the other hand, is the hypotenuse of a right triangle with shorter sides each equal to the total run of a common rafter IN THE ADDITION. The total run of a common rafter in the main roof is equal to one-half the span of the main roof; the total run of a common rafter in the addition is equal to one-half the span OF THE ADDITION.

Knowing the total run of a valley rafter (or of any rafter, for that matter), you can always find the line length by applying the bridge measure times the total run. Suppose, for example, that the span of the addition in figure 11-19 is 30 ft, and that the unit rise of a common rafter in the addition is 9. The total run of the shorter valley rafter is the square root of ($15^2 + 15^2$), or 21.21 ft. If you refer back to the unit length rafter table in figure 11-8, you will see that the bridge measure for a valley rafter in a roof with a common-rafter unit rise of 9 is 19.21. Since the unit run of a valley rafter is 16.97 and the total run of this rafter is 21.21 ft, the line length must be



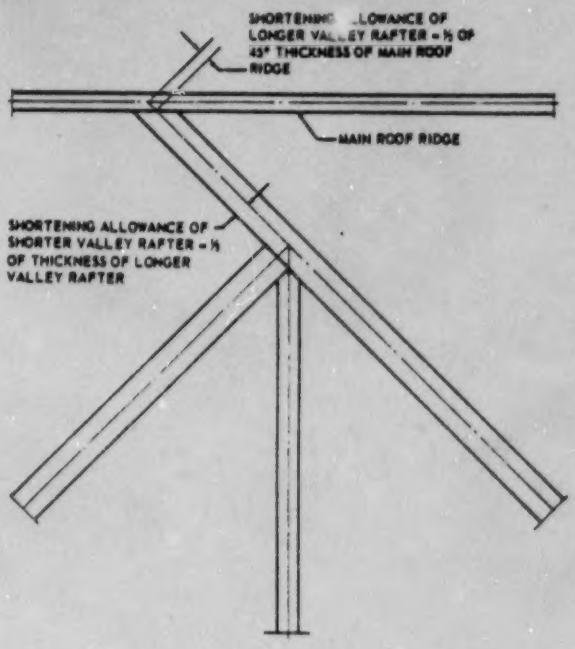
133.129

Figure 11-19.—Equal-pitch but unequal span framing situation.

the value of x in the proportional equation 16.97:19.21::21.21:x, or 24.01 ft.

An easier way to find the length of a valley rafter is to simply multiply the bridge measure by the number of feet in one-half the span OF THE ROOF TO WHICH THE VALLEY RAFTER BELONGS. The length of the longer valley rafter in figure 11-19, for example, would be 19.21 times one-half the span OF THE MAIN ROOF. The length of the shorter valley rafter is 19.21 times one-half the span OF THE ADDITION. Since one-half the span of the addition is 15 ft, the length of the shorter valley rafter is 15 x 19.21, or 288.15 in., which is 288.15/12, or 24.01 ft. Note again that when you use this method you get a result in inches, which you must change to feet.

Figure 11-20 shows the long and short valley rafter shortening allowances. Note that the long valley rafter has a single side cut for framing to the main roof ridge piece, while the


SHORTENING ALLOWANCE OF LONGER VALLEY RAFTER = ½ OF 45° THICKNESS OF MAIN ROOF RIDGE
MAIN ROOF RIDGE
SHORTENING ALLOWANCE OF SHORTER VALLEY RAFTER = ½ OF THICKNESS OF LONGER VALLEY RAFTER

133.130

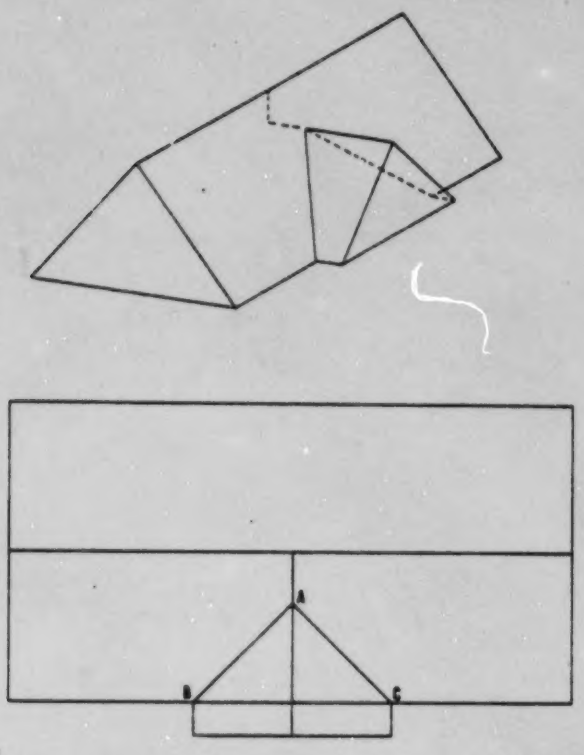
Figure 11-20.—Long and short valley rafter shortening allowances.

short valley rafter is cut square for framing to the addition ridge.

Figure 11-21 shows another method of framing an equal-pitch unequal-span addition. In this method the inboard end of the addition ridge is nailed to a piece which hangs from the main roof ridge. As shown in the framing diagram, this method calls for two short valley rafters, each of which extends from the rafter plate to the addition ridge. The framing diagram shows that the total run of each of these valley rafters is the hypotenuse of a right triangle with shorter sides, each equal to the total run of a common rafter IN THE ADDITION.

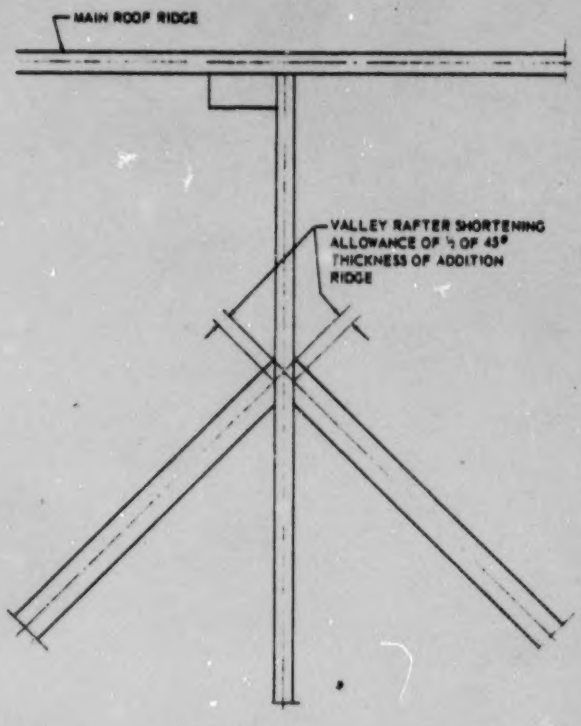
As indicated in figure 11-22, the shortening allowance of each of the short valley rafters is one-half of the 45° thickness of the addition ridge. Each rafter is framed to the addition ridge with a single side cut.

Figure 11-23 shows a method of framing a gable dormer without side walls. The dormer ridge is framed to a header set between a couple of doubled main-roof common rafters. The valley rafters are framed between this header and a lower header. As indicated in the framing diagram, the total run of a valley rafter is



133.131

Figure 11-21.—Another method of framing equal-pitch unequal span intersection.



133.132

Figure 11-22.—Shortening allowance of valley rafters in suspended ridge method of intersection roof framing.

the hypotenuse of a right triangle with shorter sides each equal to the total run of a common rafter IN THE DORMER.

Figure 11-24 shows the arrangement and names of framing members in this type of dormer framing.

Figure 11-24 also shows that the upper edges of the headers must be beveled to the cut of the main roof. Figure 11-25 shows that in this method of framing the shortening allowance for the upper end of a valley rafter is one-half of the 45° thickness of the inside member in the upper doubled header. There is also a shortening allowance for the lower end, consisting of one-half of the 45° thickness of the inside member of the doubled common rafter. The figure also shows that each valley rafter has a double side cut at the upper end and a double side cut at the lower end.

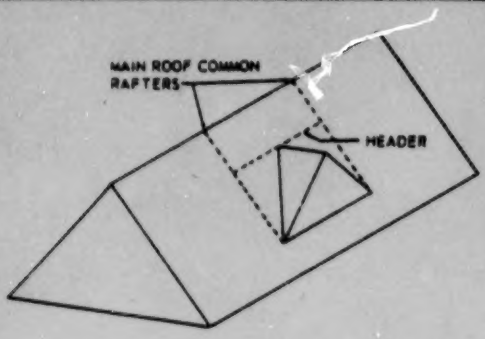
Figure 11-26 shows a method of framing a gable dormer with side walls. As indicated in the framing diagram, the total run of a valley rafter is again the hypotenuse of a right triangle with shorter sides each equal to the run of a common rafter IN THE DORMER. You figure the lengths of the dormer corner posts and side studs just as you do the lengths of gable-end studs, and you lay off the lower-end cut-off angle by setting the square to the cut of the main roof.

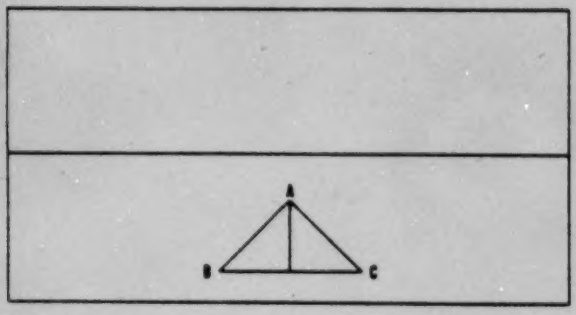
Figure 11-27 shows the valley rafter shortening allowances for this method of framing a dormer with side walls.

JACK RAFTER LAYOUT

A jack rafter is a part of a common rafter, shortened for framing to a hip rafter, a valley rafter, or both. This means that in an equal-pitch framing situation the unit rise of a jack rafter is always the same as the unit rise of a common rafter.

A HIP JACK rafter is one which extends from a hip rafter to a rafter plate. A VALLEY





133.133

Figure 11-23.—Method of framing dormer without sidewalls.

JACK rafter is one which extends from a valley rafter to a ridge. A CRIPPLE JACK rafter is one which does not contact either a rafter plate or a ridge. A VALLEY CRIPPLE JACK is one which extends between two valley rafters in the long-and-short-valley-rafter method of addition framing. A HIP-VALLEY CRIPPLE JACK is one which extends from a hip rafter to a valley rafter. All types of jacks except cripple jacks are shown in figure 11-28. A valley cripple jack and a couple of hip-valley cripple jacks are shown in figure 11-29.

Lengths of Hip Jack Rafters

Figure 11-30 shows a roof framing diagram for a series of hip jack rafters. The jacks are always on the same spacing O.C. as the common rafters. Suppose that the spacing in this instance is 16 in O.C. You can see that the total run of the shortest jack is the hypotenuse of a right triangle with shorter sides each 16 in. long. The total run of the shortest jack is therefore the square root of $(16^2 + 16^2)$, or 22.62 in.

Suppose that a common rafter in this roof has a unit rise of 8. The jacks, as you know, have the same unit rise as a common rafter. The unit length of a jack in this roof, then, is the square root of $(12^2 + 8^2)$, or 14.42. This means that a jack is 14.42 units long or every 12 units of run. The length of the shortest hip jack in this roof is therefore the value of x in the proportional equation 12:14.42::16:x, or 19.23 in.

This is always the length of the shortest hip jack when the jacks are spaced 16 in O.C. and the common rafter in the roof has a unit rise of 8. It is also the COMMON DIFFERENCE OF JACKS, meaning that the next hip jack will be 2(19.23 in.) long, the next 3(19.23 in.) long, and so on.

The common difference for hip jacks spaced 16 in. O.C., and also for hip jacks spaced 24 in. O.C., is given in the unit length rafter table on the framing square for unit rises ranging from 2 to 18 inclusive. Turn back to figure 11-8, which shows a segment of the unit length rafter table. Note the third line in the table, which reads "Diff. in length of jacks 16 inches centers." If you follow this line over to the figure under 8 (for a unit rise of 8), you will find the same unit length (19.23 in.) that you worked out above.

The best way to figure the length of a valley jack or a cripple jack is to apply the bridge measure to the total run. The bridge measure of any jack is the same as the bridge measure of a common rafter having the same unit of rise as the jack. Suppose, for example, that the jack has a unit rise of 8. In figure 11-8, look along the line on the unit length rafter tables headed "Length common rafters per foot run" for the figure in the column under 8, and you will find a unit length of 14.42. You should know by this time how to apply this to the total run of a jack to get the line length.

The best way to figure the total runs of valley jacks and cripple jacks is to lay out a framing diagram and study it to determine what these runs must be. Figure 11-31 shows part of a framing diagram for a main hip roof with a long-and-short-valley-rafter gable addition. By studying the diagram you can figure the total runs of the valley jacks and cripple jacks as follows:

The run of valley jack No. 1 is obviously the same as the run of hip jack No. 8, which is the run of the shortest hip jack. The length of

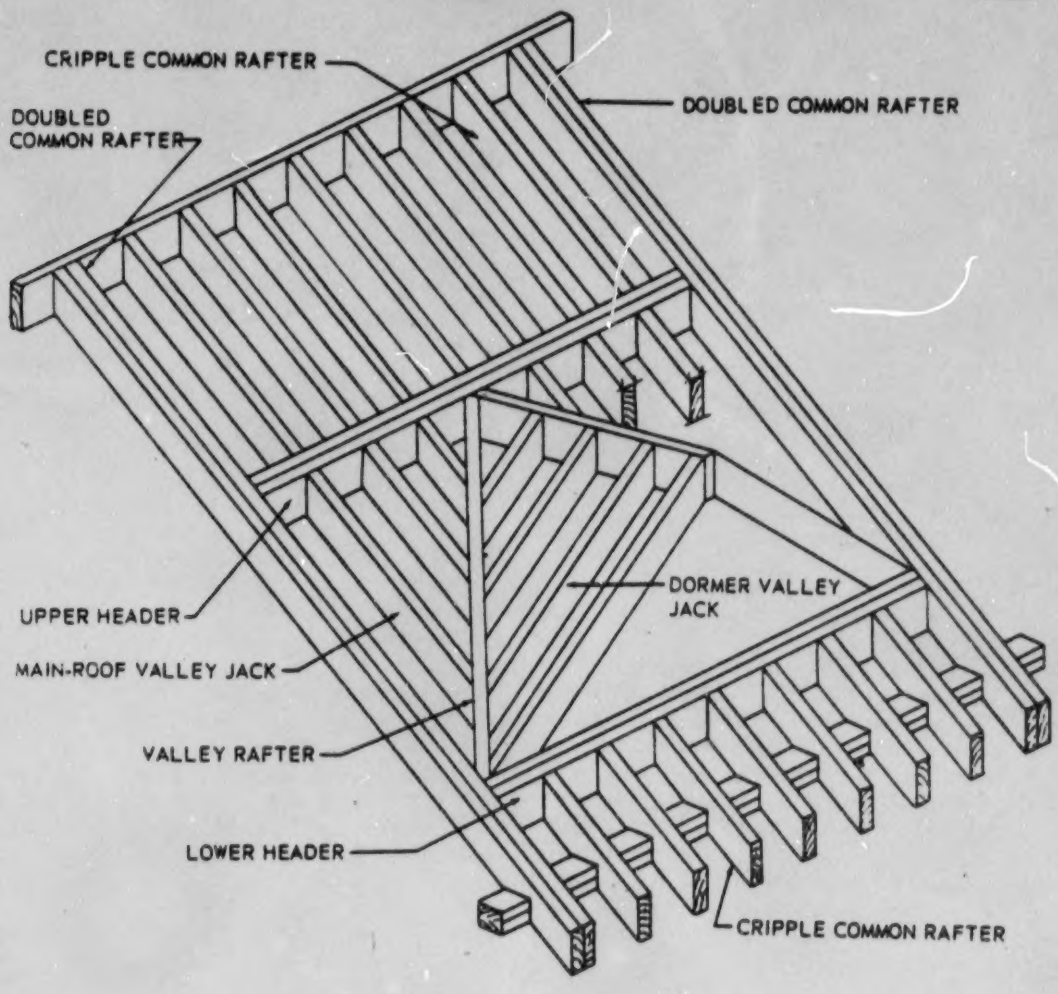


Figure 11-24.—Arrangement and names of framing members for dormer without sidewall.

valley jack No. 1 is therefore equal to the common difference of jacks.

The run of valley jack No. 2 is the same as the run of hip jack No. 7, and the length is therefore twice the common difference of jacks.

The run of valley jack No. 3 is the same as the run of hip jack No. 6, and the length is therefore three times the common difference of jacks.

The run of hip-valley cripple No. 4, and also of hip-valley cripple No. 5, is the same as the run of valley jack No. 3.

The run of valley jack No. 9, and also of valley jack No. 10, is equal to the spacing of jacks O.C. Therefore, the length of one of these jacks is equal to the common difference of jacks.

The run of valley jacks Nos. 11 and 12 is twice the run of valley jacks Nos. 9 and 10, and the length of one of these jacks is therefore twice the common difference of jacks.

The run of valley cripple No. 13 is twice the spacing of jacks O.C., and the length is therefore twice the common difference of jacks.

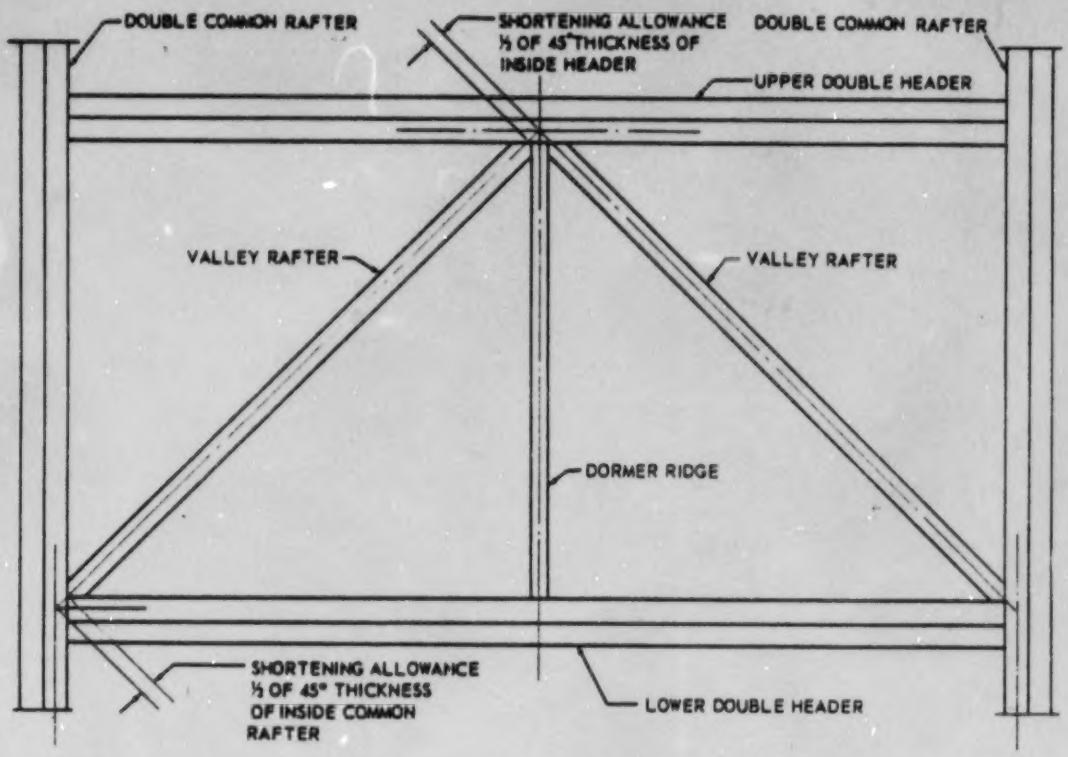


Figure 11-25.—Valley rafter shortening allowances for dormer without sidewall.

The run of valley cripple No. 14 is twice the run of valley cripple No. 13, and the length is therefore 4 times the common difference of jacks.

Jack Rafter Shortening Allowances

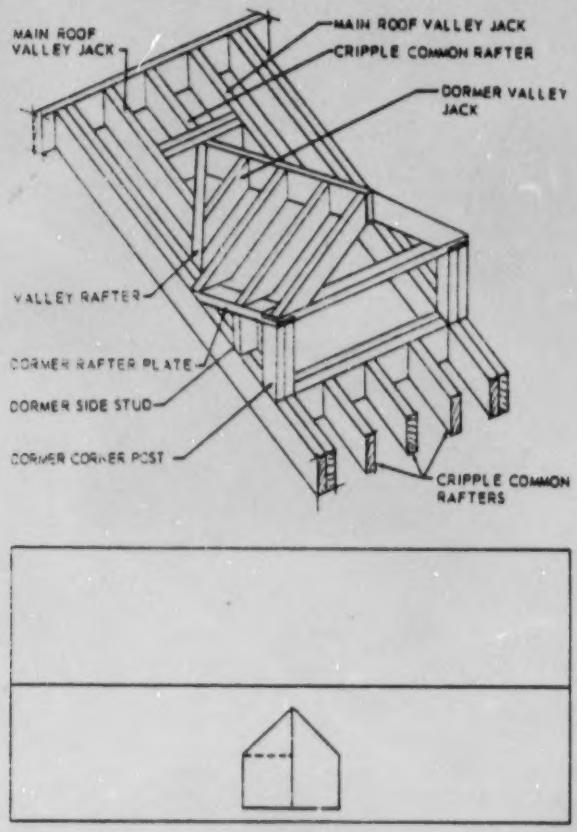
A hip jack rafter has a shortening allowance at the upper end consisting of one-half of the 45° thickness of the hip rafter. A valley jack rafter has a shortening allowance at the upper end, consisting of one-half of the thickness of the ridge, and another at the lower end, consisting of one-half of the 45° thickness of the valley rafter. A hip-valley cripple has a shortening allowance at the upper end, consisting of one-half of the 45° thickness of the hip rafter, and another at the lower end, consisting of one-half of the 45° thickness of the valley rafter. A valley cripple has a shortening allowance at the upper end, consisting of one-half of the 45° thickness of the long valley rafter, and another at the lower end, consisting of one-half the 45° thickness of the short valley rafter.

Jack Rafter Side Cuts

The side cut on a jack rafter can be laid out by the method illustrated in figure 11-14 for laying out the side cut on a hip rafter. Another method is to use the fifth line of the unit length rafter table, which is headed "Side cut of jacks use" (fig. 11-8). If you follow that line over to the figure under 8 (for a unit rise of 8), you will see that the figure given is 10. To lay out the side cut on a jack, set the square face-up on the edge of the rafter to 12 in. on the tongue and 10 in. on the blade, and draw the side-cut line along the tongue.

Jack Rafter Bird's Mouth and Projection

A jack rafter is a shortened common rafter; consequently, the bird's mouth and projection



45.458

Figure 11-26.—Method of framing gable dormer with sidewalls.

on a jack rafter are laid out just as they are on a common rafter.

RIDGE LAYOUT

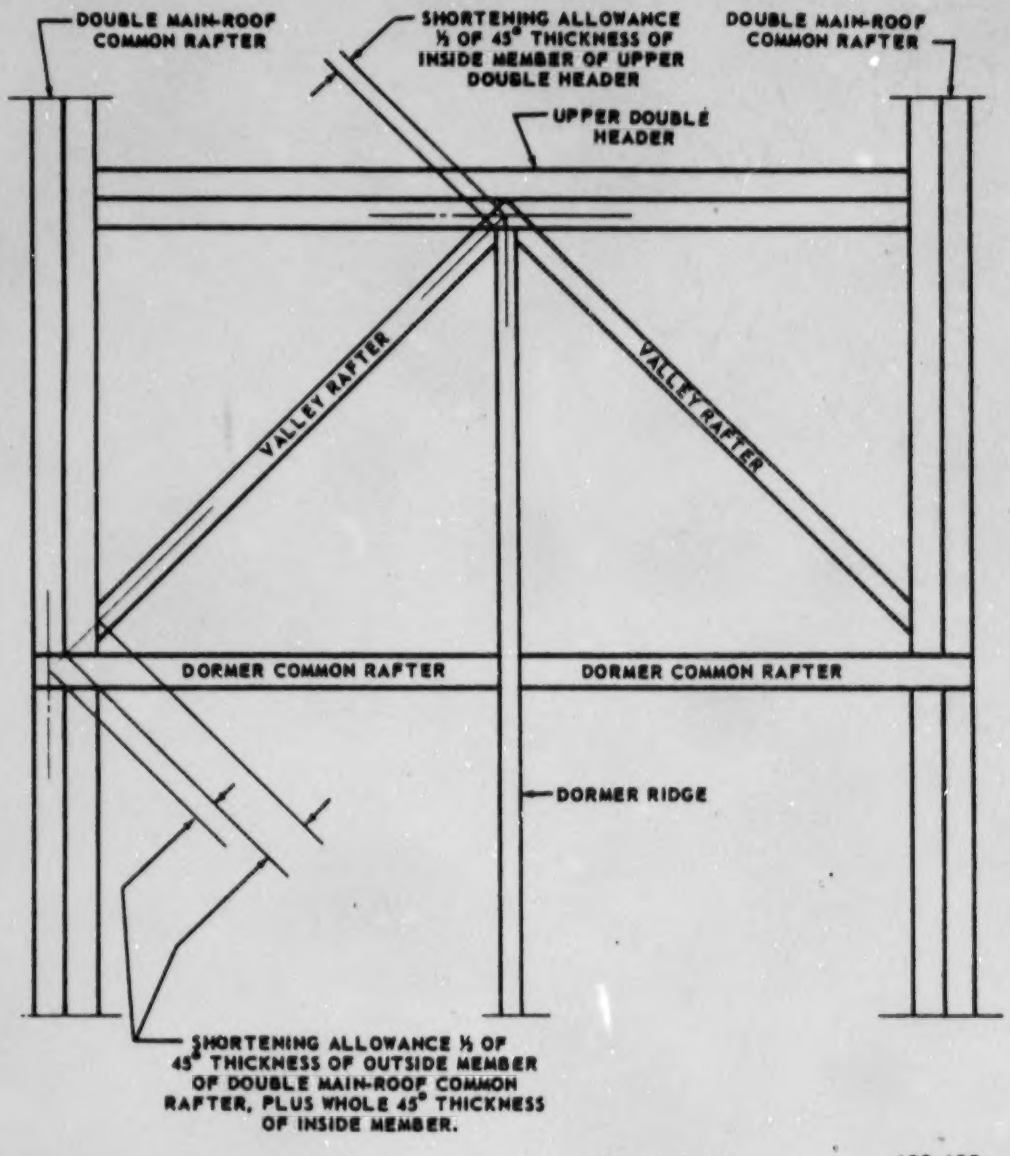
Laying out the ridge for a gable roof presents no particular problem, since the line length of the ridge is equal to the length of the building. The actual length would include any overhang. For a hip main roof, however, the ridge layout requires a certain amount of calculation.

As previously mentioned, in an equal-pitch hip roof the line length of the ridge amounts to the length of the building minus twice the total run of a main roof common rafter. The ACTUAL length, however, depends upon the way in which the hip rafters are framed to the ridge.

As indicated in figure 11-32, the line length ends of the ridge are at the points where the ridge center line and the hip rafter center lines cross. In figure 11-32 the hip rafter is framed against the ridge; in this method of framing the actual length of the ridge exceeds the line length, at each end, by one-half of the thickness of the ridge, plus one-half of the 45° thickness of the hip rafter. In figure 11-32 the hip rafter is framed between the common rafters; in this method of framing the actual length of the ridge exceeds the line length, at each end, by one-half of the thickness of a common rafter.

Figure 11-33 shows that the length of the ridge for an equal-span addition is equal to the length of the addition rafter plate, plus one-half the span of the building, minus the shortening allowance at the main roof ridge; the shortening allowance amounts to one-half of the thickness of the main roof ridge. Figure 11-33 shows that the length of the ridge for an unequal-span addition varies with the method of framing the ridge. If the addition ridge is suspended from the main roof ridge, the length is equal to the length of the addition rafter plate plus one-half the span of the building. If the addition ridge is framed by the long-and-short valley rafter method, the length is equal to the length of the addition rafter plate, plus one-half of the span of the addition, minus a shortening allowance consisting of one-half of the 45° thickness of the long valley rafter. If the addition ridge is framed to a double header set between a couple of double main roof common rafters, the length of the ridge is equal to the length of the addition side-wall rafter plate, plus one-half the span of the addition, minus a shortening allowance consisting of one-half the thickness of the inside member of the double header.

Figure 11-34 shows that the length of the ridge on a dormer without side walls is equal to one-half of the span of the dormer, less a shortening allowance consisting of one-half the thickness of the inside member of the upper double header. Figure 11-34 shows that the length of the ridge on a dormer with side walls amounts to the length of the dormer rafter plate, plus one-half the span of the dormer, minus a shortening allowance consisting of one-half the thickness of the inside member of the upper double header.


DOUBLE MAIN-ROOF COMMON RAFTER
SHORTENING ALLOWANCE ½ OF 45° THICKNESS OF INSIDE MEMBER OF UPPER DOUBLE HEADER
DOUBLE MAIN-ROOF COMMON RAFTER
UPPER DOUBLE HEADER
VALLEY RAFTER
VALLEY RAFTER
DORMER COMMON RAFTER
DORMER COMMON RAFTER
DORMER RIDGE
SHORTENING ALLOWANCE ½ OF 45° THICKNESS OF OUTSIDE MEMBER OF DOUBLE MAIN-ROOF COMMON RAFTER, PLUS WHOLE 45° THICKNESS OF INSIDE MEMBER.

133.135

Figure 11-27.—Valley rafter shortening allowances for dormer with sidewall.

SHED ROOF FRAMING

As previously mentioned, a SHED or SINGLE-PITCH roof is essentially one-half of a gable or double-pitch roof. Like the full-length rafters in a gable roof, the full-length rafters in a shed roof are COMMON rafters. Note, however, that as shown in figure 11-35, the total run of a shed roof common rafter is equal to the span of the building MINUS THE WIDTH OF THE RAFTER PLATE ON THE HIGHER RAFTER-END WALL. Note also, that the run of the projection on the higher wall is measured from the INNER EDGE of the rafter plate. To this must be added the width of the plate and the length of the overhang at the top. Shed-roof common rafters are laid out like gable-roof common rafters. A shed-roof common rafter

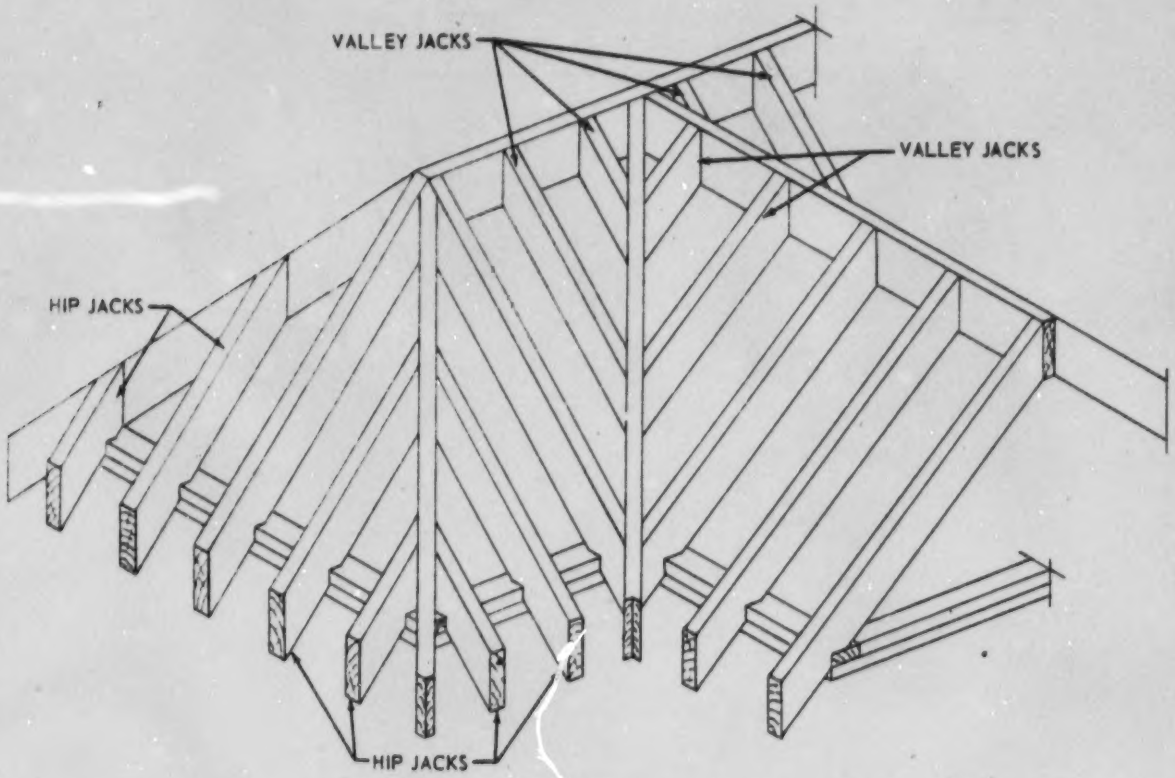


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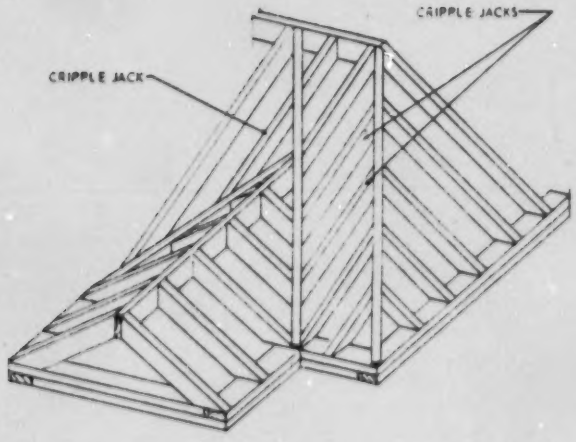
Figure 11-28.—Types of jack rafters.



45.460

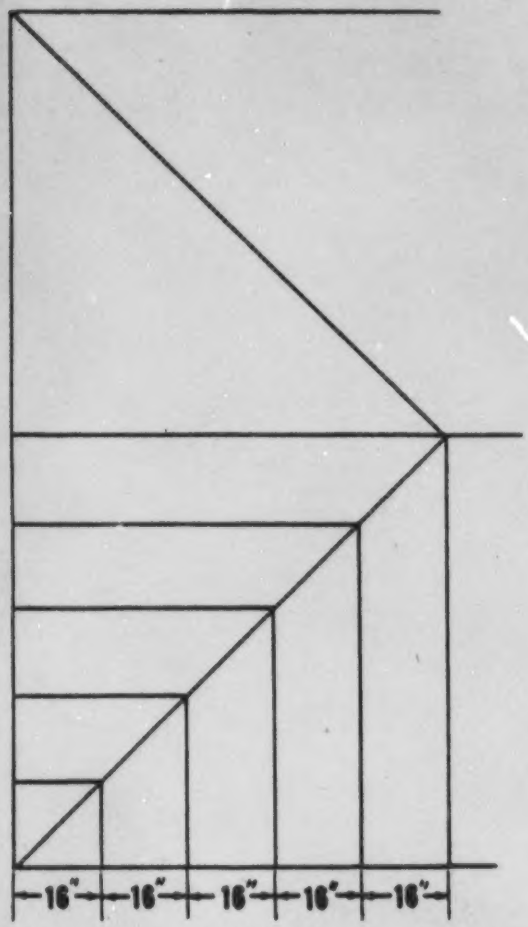
Figure 11-29.—Valley cripple jack and hip-valley cripple jacks.

has two bird's mouths, but they are laid out just like the bird's mouth on a gable-roof common rafter.

Figure 11-35 also shows that the height of the higher rafter-end wall must exceed the height of the lower by an amount equal to the total rise of a common rafter.

Figure 11-36 shows a method of framing a shed dormer. There are 3 layout problems to be solved here, as follows: (1) determining the total run of a dormer rafter, (2) determining the angle of cut on the inboard ends of the dormer rafters, and (3) determining the lengths of the dormer side-wall studs.

To determine the total run of a dormer rafter you divide the height of the dormer end wall, in inches, by the difference between the unit rise of the dormer roof and the unit rise of the main roof. Take the dormer shown in figure 11-37, for example. The height of the

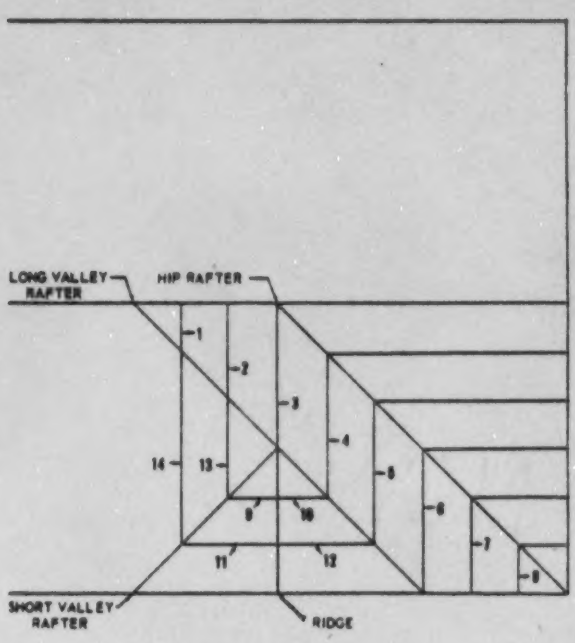


133.136

Figure 11-30.—Hip jack framing diagram.

dormer end-wall is 9 ft, or 108 in. The unit rise of the main roof is 8; the unit rise of the dormer roof is 2 1/2; the difference between them is 5 1/2. The total run of a dormer rafter is therefore 108 divided by 5 1/2, or 19.63 ft. Knowing the total run and the unit rise, you can figure the length of a dormer rafter by any of the methods already described.

As indicated in figure 11-37 the inboard ends of the dormer rafters must be cut to fit the slope of the main roof. To get the angle of this cut, set the square on the rafter to the cut of the main roof, as shown in the third view of figure 11-37; measure off the unit size of the dormer roof from the heel of the square along



133.137

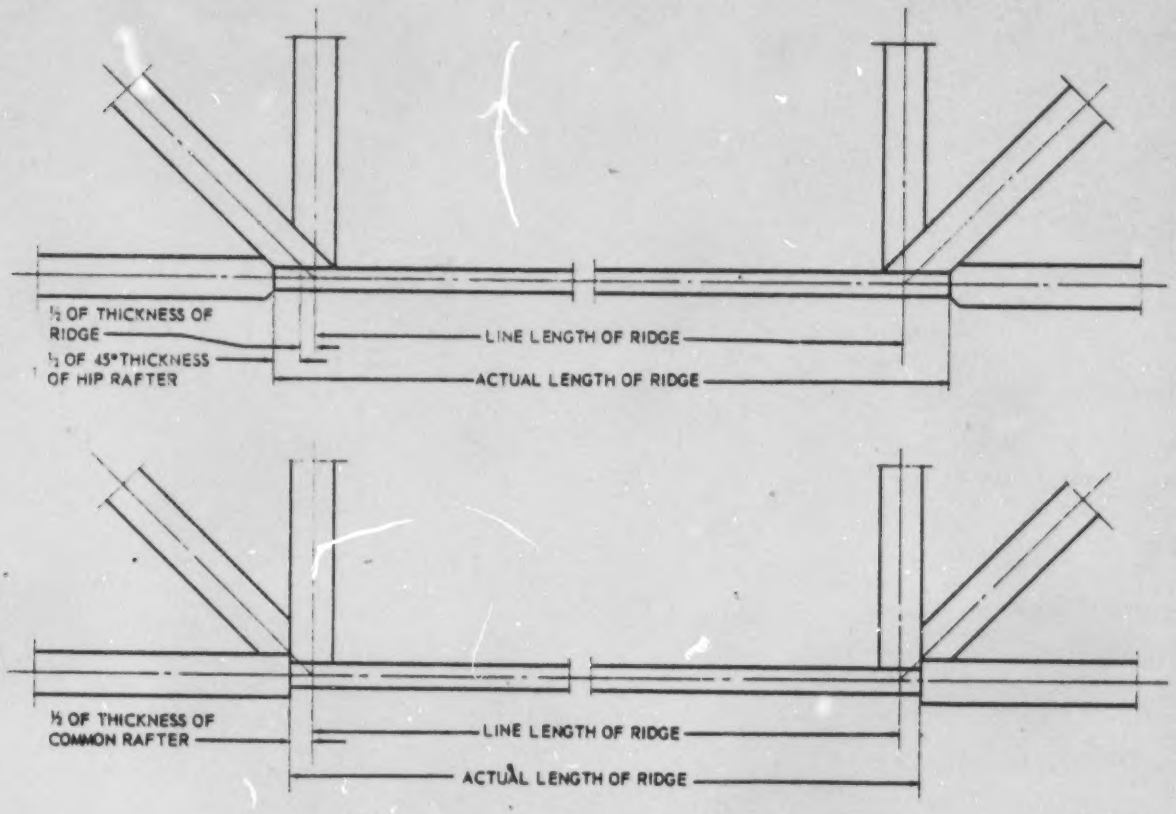
Figure 11-31.—Jack rafter framing diagram.

the tongue as indicated; make a mark at this point; and draw the cut-off line through this mark from the 12-in. mark.

You figure the lengths of the side-wall studs on a shed dormer as follows: in the roof shown in figure 11-37, a dormer rafter raises 2 1/2 units for every 12 units of run, and a main roof common rafter rises 8 units for every 12 units of run. If the studs were spaced 12 in. O.C., the length of the shortest stud (which is also the COMMON DIFFERENCE of studs) would be the difference between 8 and 2 1/2 in., or 5 1/2 in. This being the case, if the stud spacing is 16 in., the length of the shortest stud is the value of x in the proportional equation 12:5 1/2::16:x, or 7 5/16 in. The shortest stud, then, will be 7 5/16 in. long; the next stud will be 2(7 5/16)in. long, and so on. To get the lower-end cut-off angle for studs you set the square on the stud to the cut of the main roof; to get the upper-end cut-off angle you set it to the cut of the dormer roof.

RAFTER LOCATION LAYOUT

Rafter locations are laid out on plates, ridge and other rafters with the same lines and X's used to lay out stud and joist locations.


½ OF THICKNESS OF RIDGE
½ OF 45° THICKNESS OF HIP RAFTER
LINE LENGTH OF RIDGE
ACTUAL LENGTH OF RIDGE
½ OF THICKNESS OF COMMON RAFTER
LINE LENGTH OF RIDGE
ACTUAL LENGTH OF RIDGE

133.138

Figure 11-32.—Line and actual lengths of hip roof ridge.

For a gable roof the rafter locations are laid out on the rafter plates first, and the locations are then transferred to the ridge by matching the ridge against a rafter plate.

The rafter-plate locations of the ridge-end common rafters in an equal-pitch hip roof measure one-half of the span (or the run of a main-roof common rafter) away from the building corners. These locations, plus the rafter-plate locations of the rafters lying between the ridge-end common rafters, can be transferred to the ridge by matching the ridge against the rafter plates.

The locations of addition ridge and valley rafters can be determined as indicated in figure 11-38. In an equal-span situation (illustrated in parts 1 and 2, fig. 11-38) the valley rafter locations on the main roof ridge lie alongside the addition ridge location. In part 1 of figure 11-38 the distance between the end of the main roof ridge and the addition ridge location is equal to distance A plus distance B, distance B being one-half the span of the addition. In part 2 of figure 11-38 the distance between the line length end of the main roof ridge and the addition ridge location is the same as distance A. In both cases the line length of the addition ridge is equal to one-half the span of the addition plus the length of the addition side-wall rafter plate.

Part 3 of figure 11-38 shows an unequal-span situation. If framing is by the long-and-short valley rafter method, the distance from the end of the main roof ridge to the upper end of the longer valley rafter is equal to distance A plus distance B, distance B being one-half of the span of the main roof. The location of the inboard end of the shorter valley rafter on the longer valley rafter can be determined as follows: first calculate the unit length of the longer valley rafter, or obtain it from the unit-length rafter tables. Let us suppose that

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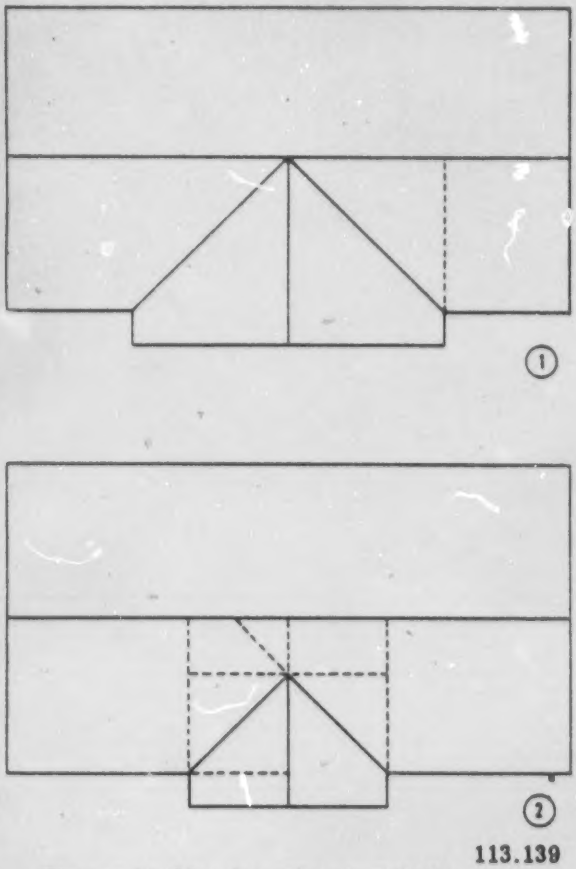

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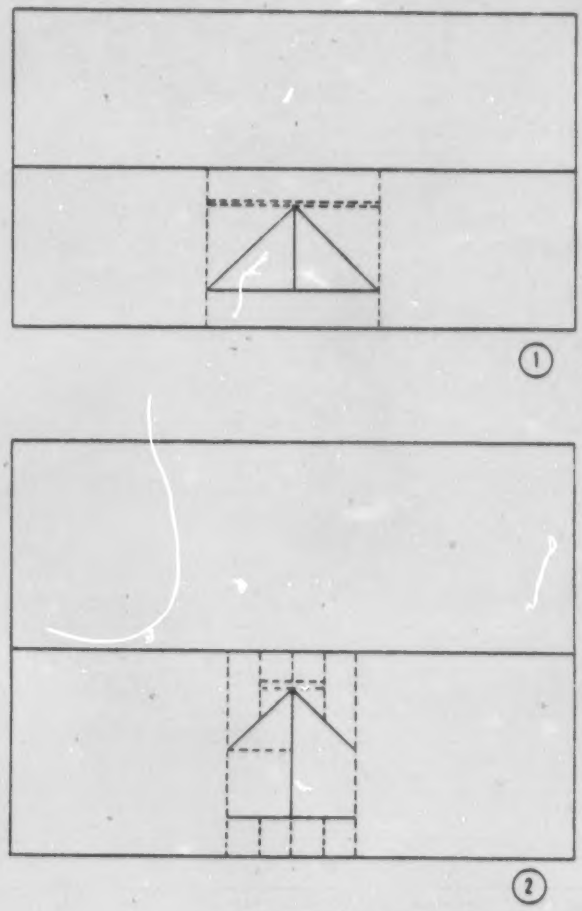
Figure 11-33.—Lengths of addition ridge.



133.140

Figure 11-34.—Lengths of dormer ridge.

the common-rafter unit rise is 8; in that case the unit length of a valley rafter is 18.76.

The total run of the longer valley rafter between the point where the shorter rafter ties in and the rafter plate is the hypotenuse of a right triangle with other sides each equal to one-half of the span of the addition. Suppose the addition is 20 ft wide; then the total run in question is the square root of $(10^2 + 10^2)$, or 14.14 ft.

You know that the valley rafter is 18.76 units long for every 16.97 units of run. The length of rafter for 14.14 ft of run must therefore be the value of x in the proportional equation 16.97:18.76::14.14:x, or 15 63 ft. The location mark for the inboard end of the shorter valley rafter on the longer valley rafter, then, will be 15.63 ft, or 15 ft 7 9/16 in., from the heel plumb cut line on the longer valley rafter. The length of the addition ridge will be equal to one-half the span of the addition, plus the length of the addition side-wall rafter plate, minus a shortening allowance equal to one-half of the 45° thickness of the longer valley rafter.

If framing is by the suspended-ridge method, the distance between the suspension point on the main roof ridge and the end of the main roof ridge is equal to distance A plus distance C; distance C is one-half of the span of the addition. The distance between the point where the inboard ends of the valley rafters (both short in this method of framing) tie into the addition ridge and the outboard end of the ridge is equal to one-half the span of the addition plus the length of the addition side-wall rafter plate. The length of the addition ridge is equal to one-half of the span of the main roof

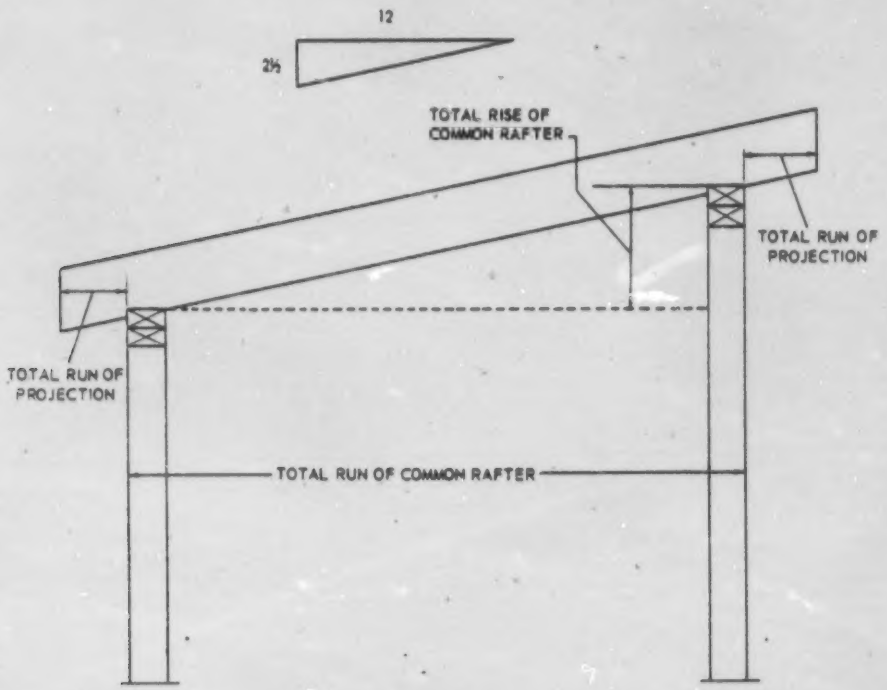


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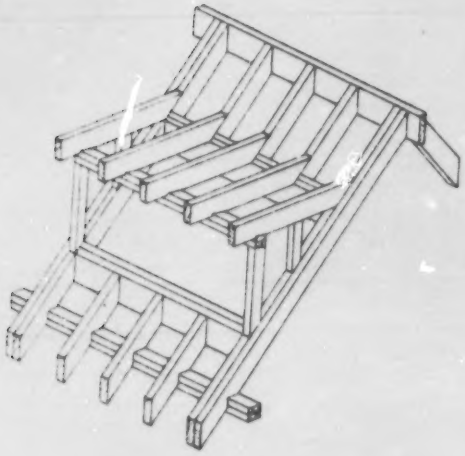
Figure 11-35.—Shed roof framing.



133.142

Figure 11-36.—Method of framing a shed dormer.

plus the length of the addition side wall rafter plate.

COLLAR TIE

Gable or double-pitch roof rafters are often reinforced by horizontal members called collar ties (fig. 11-39). In a finished attic the ties may also function as ceiling joists.

To find the line length of a collar tie divide the amount of drop of the tie in inches by the unit of rise of the common rafter. This will equal one-half the length of the tie in feet. Double the result for actual length. The formula is: Drop in inches x 2 over unit of rise, equals the length in feet.

The length of the collar tie depends on whether the drop is measured to the top edge or bottom edge of the collar tie (fig. 11-39). The tie must fit the slope of the roof. To obtain this angle, use the framing square. Hold

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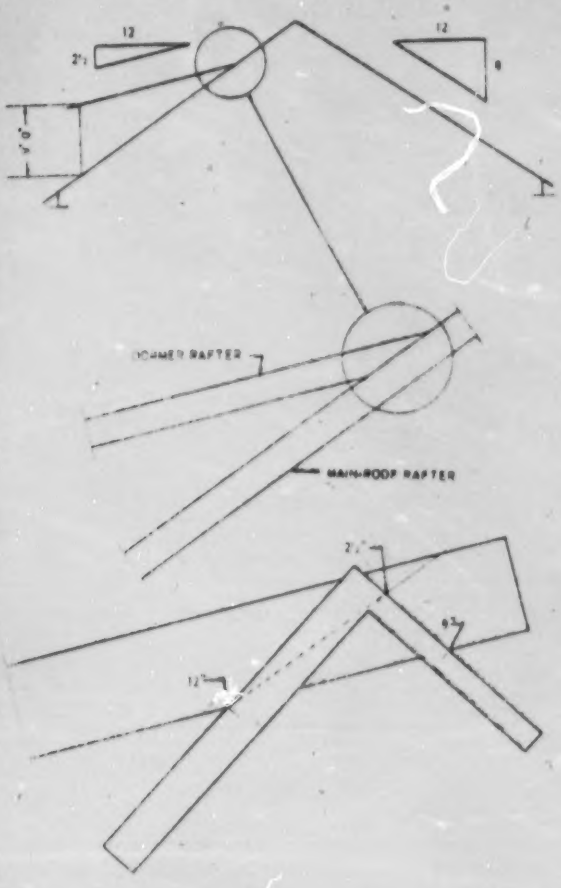

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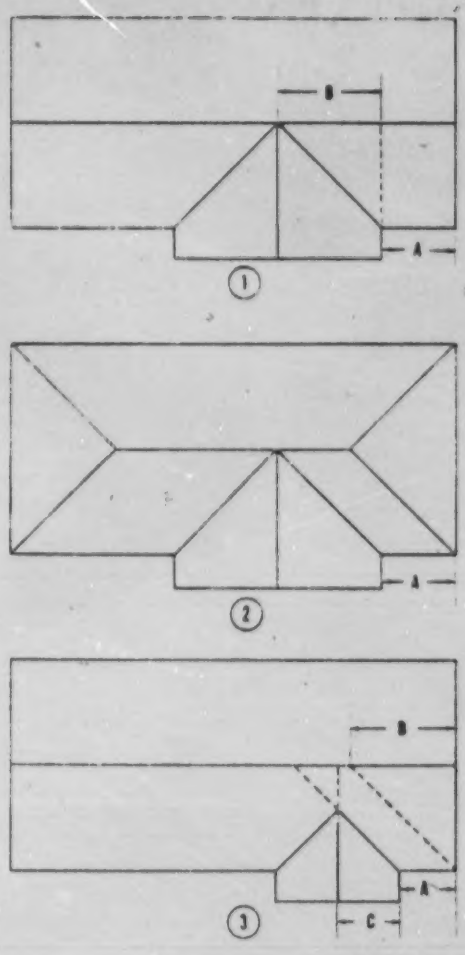
Figure 11-37.—Shed dormer framing calculations.



133.144

Figure 11-38.—Intersection ridge and valley rafter location layout.

unit of run and unit of rise of the common rafter. Mark and cut on unit of run side (fig. 11-40).

ROOF TRUSSES

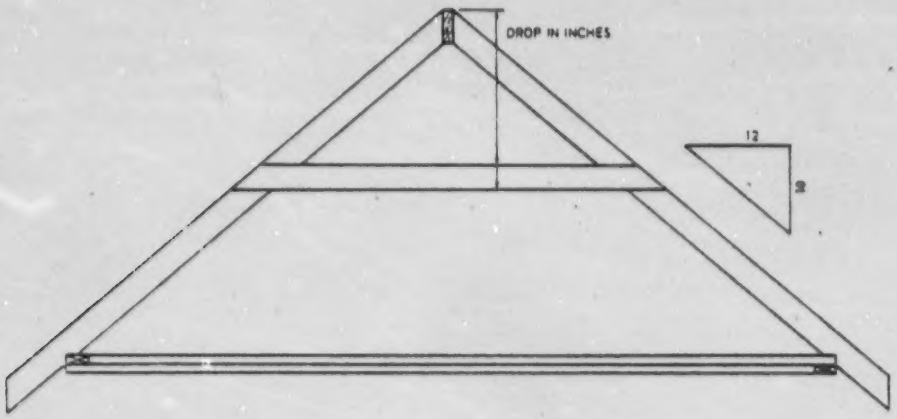
Much modern roof framing is done with ROOF TRUSSES like the one shown in figure 11-41. The principal parts of a truss are the UPPER CHORD (consisting of the rafters), the LOWER CHORD (corresponding to a ceiling joist), and various diagonal and/or vertical bracing and connecting members which are known collectively as the WEB MEMBERS.

The truss shown in figure 11-41 is joined at the corners with plywood GUSSETS. Other methods of corner joining are by metal gussets or by various types of notched joints, reinforced with bolts. Construction information on trusses is usually given in detail drawings.

ROOF FRAMING ERECTION

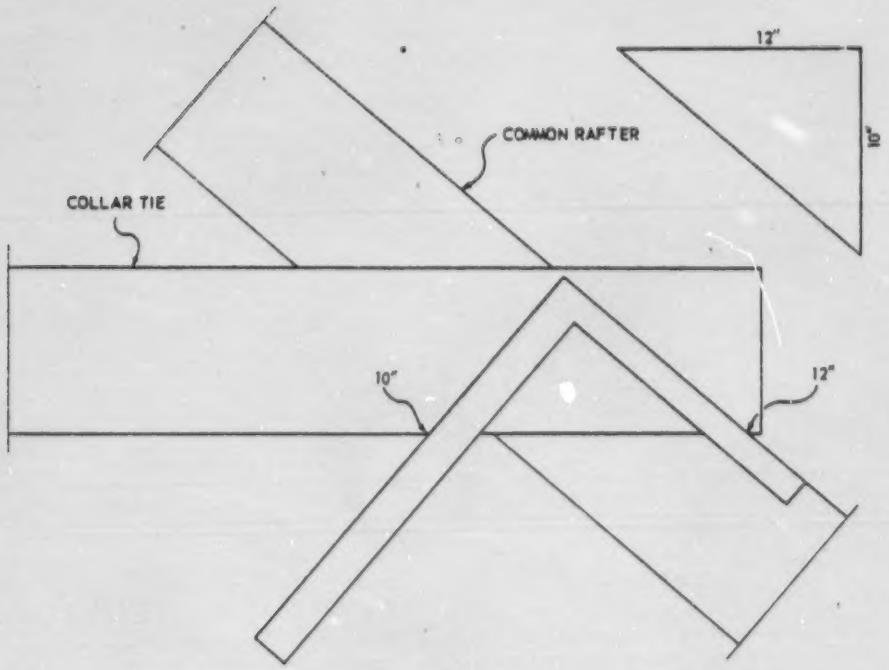
Roof framing should be done from a scaffold with planking not less than 4 ft below the level of the main roof ridge. The usual type of roof scaffold consists of diagonally-braced 2-legged horses, spaced about 10 ft apart and extending the full length of the ridge.

If the building has an addition, as much as possible of the main roof is framed before the addition framing is started. Cripples and jack



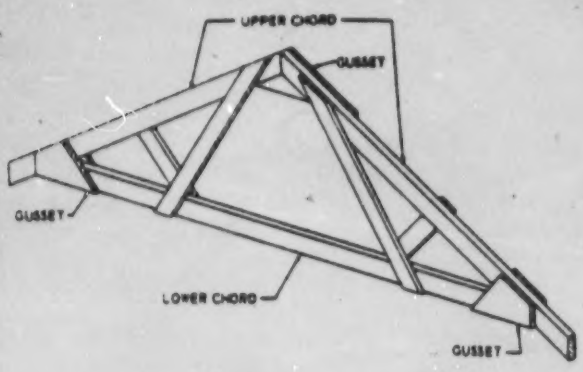
133.145

Figure 11-39.—Calculation for a collar tie.



133.146

Figure 11-40.—Laying out end cut on a collar tie.



45.438

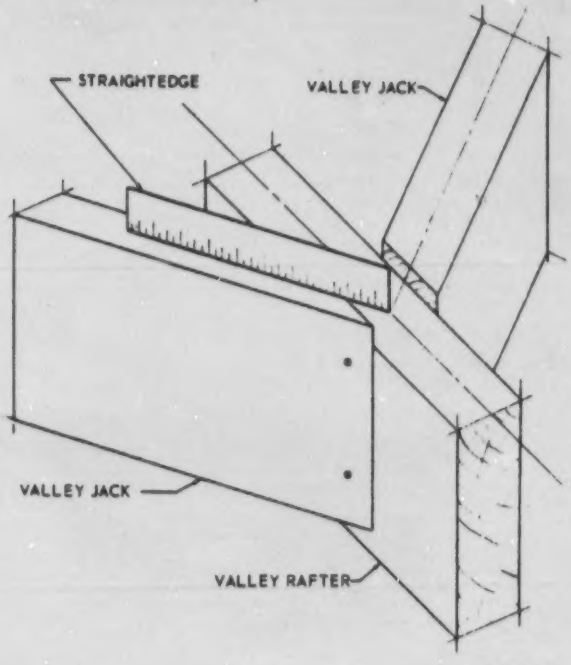
Figure 11-41.—Typical lightweight roof truss.

rafters are usually left out until after the headers, hip rafters, valley rafters, and ridges to which they will be framed have been installed.

For a gable roof the two pairs of gable-end rafters and the ridge are usually erected first. Two men, one at each end of the scaffold, hold the ridge in position, while a third man sets the gable-end rafters in place and toenails them at the rafter plate with 8-penny nails, one to each side of a rafter. Each man on the scaffold then end-nails the ridge to one of his rafters with two 10-penny nails, driven through the ridge into the end of the rafter; and toenails the other rafter to the ridge and to the first rafter with two 10-penny nails, one on each side of the rafter. Temporary braces like those for a wall should be set up at the ridge ends to hold the rafters approximately plumb, after which the rafters between the end-rafters should be erected. The braces should then be released, and the pair of rafters at one end should be plumbed with a plumb line, fastened to a stick extended from the end of the ridge. The braces should then be reset, and they should be left in place until enough sheathing has been installed to hold the rafters plumb. Collar ties, if any, are nailed to common rafters with 8-penny nails, 2 to each end of a tie. Ceiling-joist ends are nailed to adjacent rafters with 10-penny nails, 2 to each end.

On a hip roof the ridge-end common rafters and ridges are erected first, in about the same manner as for a gable roof, and the intermediate common rafters are then filled in. After that, the ridge-end common rafters extending from the ridge ends to the mid-points on the end walls are erected. The hip rafters and hip jacks are installed next. The common rafters in a hip roof do not require plumbing; if the hip rafters are correctly cut, installing the hip rafters will bring the common rafters plumb. Hip rafters are toenailed to plate corners with 16-penny nails, 2 to each side. Hip jacks are toenailed to hip rafters with 10-penny nails, 3 to each jack.

For an addition or dormer the valley rafters are usually erected first. Valley rafters are toenailed to plates with 16-penny nails, 2 to each side, and to ridge pieces and headers with three 10-penny nails. Ridges and ridge-end common rafters are erected next, other addition common rafters next, and valley and cripple jacks last. A valley jack should be held in position for nailing as shown in figure 11-42. When properly nailed, the end of a straightedge laid along the top edge of the jack should contact the center line of the valley rafter as shown.



133.147

Figure 11-42.—Correct position for nailing a valley jack rafter.

ROOF SHEATHING

The lower layer of roof covering is called the ROOF SHEATHING; the upper layer is called the ROOF COVERING or the ROOFING. The roof sheathing, like the wall sheathing and the subflooring, is a structural element and therefore a part of the framing. The roof covering or roofing is a part of the exterior finish. Roof sheathing, like wall sheathing and subflooring, may be laid either horizontally or diagonally. Horizontal sheathing may be either CLOSED sheathing (laid with no spaces between courses) or OPEN sheathing (laid with spaces between courses). Open sheathing is used for the most part only when the roof covering is to consist of wooden shingles. Closed sheathing is usually nominal 6-in. in width; it may consist of square-edged boards but may be dressed-and-matched or shiplap. Open sheathing usually consists of 1 x 3 or 1 x 4 strips, with spacing O.C. equal to the specified exposure of shingles TO THE WEATHER. An 18-in. shingle which is lapped 12 in. by the shingle above it is said to be laid 6 in. to the weather.

Sheathing should be nailed with two 8-penny nails to each rafter crossing. End-joint requirements are the same as those previously described for wall sheathing. The sheathing ends should be sawed flush with the outer face of the end-wall sheathing, unless a projection of the roof sheathing over the end-walls is called for. If such a projection is needed, projecting sheathing boards must be long enough to span at least 3 rafter spaces.

Plywood, usually in 8-ft x 4-ft sheets, laid horizontally, is frequently used for roof sheathing. Nailing requirements are the same as those previously described for 8-ft x 4-ft sheets of plywood wall sheathing.

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SPECIAL CONSTRUCTION BATTALION TRAINING

BUILDERS SCHOOL

150.1 Light Frame Construction I

3-11

MAY 1975

61

TITLE PAGE

TITLE: SPECIAL CONSTRUCTION BATTALION TRAINING COURSE 150.1
LIGHT FRAME CONSTRUCTION 1.

COURSE NUMBER: SCBT 150.1

COURSE LENGTH: 50 Hours.

TAUGHT AT: Naval Construction Training Center
Port Hueneme, California 93043

CLASS CAPACITY: Maximum - 16
Minimum - 8

INSTRUCTOR REQUIREMENTS PER CLASS: 1 instructor per 16 students

COURSE CURRICULUM MODEL MANAGER: Naval Construction Training Center
Port Hueneme, California 93043

CURRICULUM CONTROL: Chief of Naval Technical Training.

QUOTA MANAGEMENT AUTHORITY: School at which taught.

APPROVAL/IMPLEMENTATION DATE: When approved by the Chief of Naval Technical Training

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COURSE DATA PAGE

COURSE MISSION: To train select builders and builder strikers in the knowledge and skill factors defined by the personnel readiness capability program, skill level 150.1.

PERSONNEL AND RATING ELIGIBLE: E-2 thru E-4

OBLIGATED SERVICE: NONE

NEC EARNED: N/A.

PHYSICAL REQUIREMENTS: NONE

SECURITY CLEARANCE REQUIRED: NONE

PREREQUISITE TRAINING AND/OR BASIC BATTERY TEST SCORE REQUIRED: NONE

RELATED TRAINING: NONE

FOLLOW-UP TRAINING: NONE

EVALUATION: Performance will be evaluated on a go/no go basis.

OUTLINE OF INSTRUCTION

TOPIC	Unit 1.1	CLASS	PRACT	TOTAL	PAGE
	INTRODUCTION				
1.1.1	Orientation	1.5	0	1.5	3
1.1.2	Safety	.5	0	.5	3
		2	0	2	
	Unit 1.2				
	Light Frame Structures				
1.2.1	Sills and Girders	3	3	6	3
1.2.2	Floor Joists and Solid Bridging	1	4	5	3
1.2.3	Subfloors and Wall Plates	2	3	5	4
1.2.4	Wall Members	2	15	17	4
1.2.5	Ceiling and Roof Construction	3	4	7	4
1.2.6	Gable End Studs	1	2	3	4
1.2.7	Course Summarization	1	4	5	4
		13	35	48	

Total Periods Classroom: 15
Total Periods Practical: 35
Total Hours Per Course: 50

* Each period of instruction represents 60 minutes actual instruction.

OUTLINE OF TRAINING OBJECTIVES

Unit 1.1 INFORMATION — Contact Hours: 2

Terminal Objective: Upon completion of this unit the student will have reported to Builder School and received the school orientation and safety procedures required to complete the assigned course of instruction as a SCBT student.

Topic 1.1.1 ORIENTATION — Contact Hours: 1.5

Enabling Objective: Upon completion of this topic the student will have reported for the course and answered questions pretaining to key points on the organization, mission and regulations of NAVCONSTRACEN.

Topic 1.1.2 SAFETY — Contact Hours: 0.5

Enabling Objective: Upon completion of this topic the student will be able to report accidents or fire and state the safety practices that will be enforced in the school.

Unit 1.2 LIGHT FRAME CONSTRUCTION — Contact Hours: 48

Terminal Objective: Upon completion of the unit the student will have met all the requirements of the Personnel Readiness Capability Program, skill level 150.1 - Light Frame Construction I involving substructure framing, wall framing and roof framing. The light frame structures are to be erected by following the procedures and meeting the specifications stated in the job sheet.

Topic 1.2.1 SILLS AND GIRDERS — Contact Hours: 6

Enabling Objective: Upon completion of this topic the student will be able to lay out, cut and install sills and girders following procedures in accordance with job sheets SCBT 150.1 BU JS 1.2.1.1, "Installing Sill Plates," and SCBT 150.1 BU JS 1.2.1.2, "Placing and Posting Girders". The installed sill plates and girders will be within job sheet specifications.

Topic 1.2.2 FLOOR JOISTS AND SOLID BRIDGING — Contact Hours: 5

Enabling Objective: Upon completion of this topic the student will be able to lay out, cut and install floor joists and solid bridging following procedures in job sheet SCBT 150.1 BU JS 1.2.2.1, "Floor Joists and Bridging (solid) Layout and Erection". The installed floor framing will be within job sheet specifications.

Topic 1.2.3. SUBFLOORS AND WALL PLATES Contact Hours: 5

Enabling Objectives: Upon completion of this topic the student will be able to lay out, cut and install subflooring and wall plates following procedures in job sheet SCBT 150.1 BU JS 1.2.3.1. "Installing Subfloors" and SCBT 150.1 BU JS 1.2.3.2, "Laying Out Sole and Top Plates". The installed subflooring and sole plates will be within job sheet specifications.

Topic 1.2.4 WALL MEMBERS Contact Hours: 17

Enabling Objectives: Upon completion of this topic the student will be able to lay out, cut and install studs, fire blocks, headers, sills and bracing following procedures and meeting the specifications outlined in job sheets SCBT 150.1 BU JS 1.1.4.1, "Erecting and Securing Wall Sections," SCBT 150.1 BU JS 1.1.4.2, "Installing Fire Blocks and Diagonal Bracing," and SCBT 150.1 BU JS 1.2.4.3, "Installing Trimmer Studs, Cripple Studs, Sills and Headers".

Topic 1.2.5 CEILING JOISTS AND ROOF CONSTRUCTION Contact Hours: 7

Enabling Objective: Upon completion of this topic the student will be able to lay out, cut and install ceiling joists and rafters following procedures in accordance with job sheets SCBT 150.1 BU JS 1.1.5.1. "Cutting and Installing Ceiling Joists", SCBT 150.1 BU JS 1.1.5.2., "Raising Roof Frames", and SCBT 150.1 BU JS 1.2.5.3., "Laying Out Common Rafters". The installed ceiling joists and rafters will be within job sheet specifications.

Topic 1.2.6 GABLE END STUDS Contact Hours: 3

Enabling Objective: Upon completion of this topic the student will be able to lay out, cut and install gable end studs following procedures in accordance with job sheet SCBT 150.1 BU JS 1.2.6.1, "Laying Out, Cutting and Installing Gable End Studs." The installed studs will be within job sheet specifications.

Topic 1.2.7 COURSE SUMMARIZATION Contact Hours: 5

Enabling Objective: Upon completion of this topic the student will have reinforced his ability to identify by naming all the framing members in accordance with the texts as the members are pointed out by the instructor. The student will also have reviewed the methods used in the erection of the light frame structure as a structure is torn down. The dismantled framing members will be clear of all nails and will be neatly stacked.

ANNEX I

TEXTS

1. Builder 3 & 2, NAVPERS 10648-F

2. Framing, Sheathing and Insulation, Delmar Publishing Company

ANNEX II

REFERENCES

1. Fundamentals of Carpentry, American Technical Society.

2. Practical Carpentry, Goodheart-Wilcox Company.

ANNEX III

TOOLS, EQUIPMENT AND MATERIAL

TOOLS:

NSN/MFG. NO.	ITEM	QUANT.	PRICE
5110-00-186-8171	Chisel, Wood 1 1/2"	1 ea.	9.60
5110-00-293-3435	Saw, Cross cut 8 points	1 ea.	3.35
5120-00-293-0665	Bar, Wrecking 3/4 X 30"	1 ea.	1.95
5120-00-449-8083	Wrench, Adjustable 1 1/8 X 10"	1 ea.	3.20
5120-00-892-5485	Hammer, Carpenter 16 oz.	1 ea.	3.60
5130-00-293-3456	Drill, portable electric 3/8" dia.	1 ea.	45.50
5133-00-228-1327	Drill Bit, 5/8" dia. (12 to a pkg.)	1 pkg.	4.20
5210-00-078-8948	Square, Combination 12 in.	1 ea.	7.10
5210-00-221-2050	Square, Framing	1 ea.	4.40
5210-00-273-9793	Chalk Line and Reel	1 ea.	.83
5210-00-278-0645	Square, Sliding-T-Bevel	1 ea.	1.24
5210-00-293-3505	Measuring Tape, 10 ft.	1 ea.	.94
5210-00-926-5430	Level, hand, carpenter 28 in.	1 ea.	4.45
	Saw, Circular, portable, electric 7 inch blade	1 ea.	60.00

EQUIPMENT:

5440-00-514-9487	Ladder, Step 8 Ft.	1 ea.	17.40
6150-00-665-7972	Extension cord, single outlet	1 ea.	1.75
7510-00-272-9436	Keel, blue,soft (doz)	1 bx.	.65
8415-00-205-3895	Apron, nail, carpenter	1 ea.	2.50
	Saw horse		

MATERIALS:

2 x 4's

2 x 6's

TOOLS, EQUIPMENT AND MATERIAL (Cont'd)

	1 x 6's		
	4 x 4's		
	4 x 6's		
	3/4" X 4' 0 X 8' 0 Plywood		
5315-00-010-4659	Nails 8d com. 50# box	1 bx.	13.50
	Nails 8d duplex		
5315-00-010-4663	Nails,16d com 50# box	1 bx.	13.50

Transparencies (cont'd)

16. NP-311013.3T-12 Framed Opening (window)

17. 11CS-11013.101T-2 Platform Western Frame Construction

18. 11CS-10321.101T-2 Rafter Cuts

19. 11CS-10321.101T-1 Rafter Measurements

20. 11CS-7400064-T Common Rafter Layout.

Charts

1. Illustrating sub-structure of a frame structure.

2. Illustrating frame structure.

Sample

1. 2 x 4

2. 2 x 6

3. 4 x 4

4. 4 x 6

5. 8d box nail

6. 16d box nail

Model

1. Platform Frame Building

Locally Prepared Materials

1. Floor Plan

Job Sheets

1.	SCBT 150.1 BU JS 1.2.1.1	Installing Sill Plates
2.	SCBT 150.1 BU JS 1.2.1.2	Placing and Posting Girders
3.	SCBT 150.1 BU JS 1.2.2.1	Floor Joists and Bridging (solid) Layout and Erection
4.	SCBT 150.1 BU JS 1.2.3.1	Installing Subfloor
5.	SCBT 150.1 BU JS 1.2.3.2	Laying Out Sole and Top Plates.
6.	SCBT 150.1 BU JS 1.2.4.1	Erecting and Securing Wall

ANNEX IV

TRAINING AIDS

Films:

1. HOW-016 How to use Measuring Tools.
2. HOW-018 How to use Saws.
3. HOW-014 How to use Hammers.
4. HOW-015 How to use Hand Boring Tools.
5. MN-6719B Building Technique - Framing Floor Joists and Wall.
6. GIF-001 The Gift of Life.
7. MN-6719-C Building Technique - Framing, Rafter Principles and Common Rafter.

Transparencies:

1. 11CS-7400055-T Sill
2. 11CS-7400056-T Sill and Girder
3. 11CS-7400057-T Framing Joists and Girder
4. 11CS-10321.101T-5 Floor Joists Layout
5. 11CS-7400058-T Wood Bridging
6. 11CS-10321.101T-3 Rough Opening for Windows.
7. 11CS-10321.101T-4 Rough Opening for Doors
8. 11CS-7400059-T Subfloor
9. 11CS-7400060-T Subfloor and Underlay
10. NP-311013.3T-8 Sole Plate
11. 11CS-7400065-T Corner Balloon and Platform Framing
12. NP-311013.3T-13 Platform Framing
13. NP-311013.3T-14 Platform Framing
14. 11CS-7400063-T Wall Backing
15. NP-311013.3T-9 Bracing in Framing

Job Sheets (cont'd)

7.	SCBT 150.1 BU JS 1.2.4.2	Installing Fire Blocks and Diagonal Bracing.
8.	SCBT 150.1 BU JS 1.2.4.3	Installing Trimmer Studs, Cripple Studs, Sills and Headers.
9.	SCBT 150.1 BU JS 1.2.5.1	Cutting and Installing Ceiling Joists.
10.	SCBT 150.1 BU JS 1.2.5.2	Raising Roof Frames
11.	SCBT 150.1 BU JS 1.2.5.3	Laying Out Common Rafters.
12.	SCBT 150.1 BU JS 1.2.6.1	Laying Out, Cutting and Installing Gable End Studs.

ANNEX V

TRAINING AIDS EQUIPMENT

1. 16mm Movie Projector
2. Overhead Projector.

ANNEX VI

FIRST WEEK

TOPIC NO.	TYPE	PERIOD	TITLE	RATIO
FIRST DAY				
1.1.1	C	1	Orientation	16/1
		2		
1.1.2	C	2.5	Safety	16/1
1.2.1	C	3	Sills and Girders	16/1
		4		
		5		
	P	6		16/1
		7		
SECOND DAY				
1.2.1	P	8	Sills and Girders	16/1
1.2.2	C	9	Floor Joists and Solid Bridging	16/1
	P	10		16/1
		11		
		12		
		13		
1.2.3	C	14	Sub floors and Wall Plates	16/1
THIRD DAY				
1.2.3	C	15	Sub floors and Wall Plates	16/1
	P	16		16/1
		17		
		18		
1.2.4	C	19	Wall Members	16/1
		20		
	P	21		16/1
FOURTH DAY				
1.2.4	P	22	Wall Members	16/1
		23		
		24		
		25		
		26		
		27		
		28		
FIFTH DAY				
1.2.4	P	29	Wall Members	16/1
		30		

SECOND WEEK

TOPIC NO.	TYPE	PERIOD	TITLE	RATIO
FIRST DAY				
1.2.4.	P	1	Wall Members	16/1
		2		
		3		
		4		
		5		
1.2.5.	C	6	Ceiling Joists and Roof Construction	16/1
		7		
SECOND DAY				
1.2.5.	C	8	Ceiling Joists and Roof Construction	16/1
	P	9		16/1
		10		
		11		
		12		
1.2.6	C	13	Gable End Studs	16/1
	P	14		16/1
THIRD DAY				
1.2.6	P	15	Gable End Studs	16/1
1.2.7	C	16	Course Summarization	16/1
	P	17		16/1
		18		
		19		

MODIFICATIONS

Instructor Guide
1.1.1 of this publication has (have) been deleted in adapting this material for inclusion in the "Trial Implementation of a Model System to Provide Military Curriculum Materials for Use in Vocational and Technical Education." Deleted material involves extensive use of military forms, procedures, systems, etc. and was not considered appropriate for use in vocational and technical education.

NAVAL CONSTRUCTION TRAINING CENTER
PORT HUENEME, CALIFORNIA 93043
SPECIAL CONSTRUCTION BATTALION TRAINING COURSE (SCBT) 100 - 190

Classification: Unclassified

Topic: Safety

Average Time: 0.5 Periods (Class)

Instructional Materials:

A. Texts: None.

B. References.

1. NAVCONSTRACENINST. 5400.4, (current series) "Organization Manual of NAVCONSTRACEN."

2. "Safety Practices for Shore Activities," NAVMAT P-5100, (Jan 1973).

C. Tools and Equipment: None.

D. Training Aids and Devices.

1. Film.

a. GIF-001, "The Gift of Life," (18 min.)

E. Training Aids Equipment.

1. 16mm Movie Projector.

Terminal Objective: Upon completion of this unit the student will have reported to Builder School, received the school orientation and safety procedures required to complete the assigned course of instruction as a SCBT student.

Enabling Objectives: Upon completion of this topic the student will be able to report accidents or fire, and state the safety practices that will be enforced in the school.

Criterion Test: The student will answer orally specific question pertaining to the method of reporting and fighting fires as established by NAVCONSTRACEN and CBC regulations, and will conform to the safety policies for the duration of his assignment to Builder School.

Homework: None.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. Introduction to the Lesson:		
A. Establish contact.	I.A. Introduce self and topic.	
1. Name:		
2. Topic: Safety.		
B. Establish readiness.	I.B. Motivate student.	
1. Purpose.		
2. Assignment.		
C. Establish effect.	I.C. Bring out need and value of material being presented.	
1. Value.		
a. Pass course.		
b. Perform better on the job.		
D. Overview.	I.D. State learning objectives.	
1. You will be able to answer orally specific questions related to the methods of reporting and fighting fires as established by NAVCONSTRACEN and CBC regulations and conform to the safety practices that will be enforced in this school.	1. State information and materials necessary to guide student.	
2. Ask questions.		
3. Take notes.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
II. Presentation:		
A. Safety.		
1. Reporting accidents.		
a. Class safety man.	1.a. Pick safety mand and explain job.	
b. Instructor.		
c. School director.		
d. First aid when appropriate.		
2. Fire safety.		
a. Evacuation routes.		
b. Reporting fires.		
c. Fighting fire.		
(1) Location of extinguishers.		
3. Field safety.	A.3. Introduce film.	
a. Show film: GIF-001, "The Gift of Life."	a. Discuss key points to look for.	
	b. Show film.	
b. Discuss film highlights.	3.b. Lead discussion.	3.b. Participate in discussion - ask questions as necessary.
	1. Ask questions.	
	2. Stress safety.	

S3

S4

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
III. Application:		
A. Discussion.	III.A. Questions to be developed by the instructor.	III.A. Answer and ask questions.
IV. Summary:		
A. Safety.		
1. Reporting accidents.		
2. Fire safety.		
3. Field safety.		
V. Test:		
A. None.		

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SCBT-150.1-BU-IG-1.2.1

NAVAL CONSTRUCTION TRAINING CENTER
PORT HUENEME, CALIFORNIA 93043
SPECIAL CONSTRUCTION BATTALION TRAINING COURSE (SCBT) 150.1

Classification: Unclassified

Topic: Sills and Girders

Average Time: 3 Periods (Class)
3 Periods (Pract)

Instructional Materials:

A. Texts.

1. Builder 3&2, NAVPERS 10648-F, Chapter 10.

2. Framing, Sheathing and Insulation, Delmar Publishing Co., Units 3 & 4.

B. Reference.

1. Fundamentals of Carpentry, American Technical Society.

C. Tools and Equipment.

1. Measuring tape.

2. Combination square.

3. Hand level.

4. Extension cord.

5. Framing square.

6. Hammer.

Terminal Objective: Upon completion of this course the student will have met all the requirements of personnel readiness capability program, skill level 150.1 - Light Frame Construction I involving sill plate, post, girder, floor joist, bridging, sub-flooring, plate, ridge piece and gable end stud. The light frame structure is to be erected by following procedures in accordance with job sheets and to within the requirements as stated on the job sheets.

Enabling Objectives: Upon completion of this topic the student will be able to lay out, cut and install sills and girders following procedures in accordance with job sheets SCBT-150.1-BU-JS-1.2.1.1, "Installing Sill Plates," and SCBT-150.1-BU-JS-1.2.1.2, "Placing and Posting Girders." The installed sill plates and girders will be within job sheet specifications.

Criterion Tests: Given the proper tools, materials and job sheets, the student will be tested on his ability to correctly use and care for carpenter hand tools and portable electric tools. He will perform all tasks as outlined in the objectives and will meet all tolerances as stated in the job sheets.

Homework: Read: Builder 3&2, NAVPERS 10648-F, Chapter 10 and Framing, Sheating and Insulation, Units 3 & 4, pp. 19 - 25.

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7. Chisel.

8. Portable electric circular saw.

9. Portable electric drill.

10. Drill bits.

11. Adjustable wrench.

12. Saw horses.

13. Nail apron.

D. Training Aids and Devices.

1. Films.

a. HOW-016, "How to Use Measuring Tools," (12 min.).

b. HOW-018, "How to Use Saws," (12 min.).

c. HOW-014, "How to Use Hammers," (12 min.).

d. HOW-015, "How to Use Hand Boring Tools," (10 min.).

e. MN-6719B, "Building Technique - Framing Floor Joist and Wall," (25 min.).

2. Transparencies.

a. 11CS-7400055-T, Sill.

b. 11CS-7400056-T, Sill and Girder.

c. 11CS-7400056-T, Framing Joists and Girder.

3. Materials.

a. 2 x 4's, 2 x 6's, 4 x 4's and 4 x 6's.

4. Platform frame building (model).

5. Chart(s) illustrating sub-structures of a frame building.

6. Samples of Materials.

a. 2 x 4.

b. 2 x 6.

c. 4 x 4.

d. 4 x 6.

e. 8d box nails.

f. 16d box nails.

7. Locally prepared materials.

a. Job sheets.

(1) SCBT-150.1-BU-JS-1.2.1.1, "Installing Sill Plates."

(2) SCBT-150.1-BU-JS-1.2.1.2, "Placing and Posting Girders."

E. Training Aids Equipment.

1. 16mm movie projector.

2. Overhead projector.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. Introduction to the Lesson:		
A. Establish contact.		
1. Name:	A.1. Introduce self.	
2. Topic: Sills and Girders.	A.2. Introduce topic.	
B. Establish readiness.		
1. Purpose.	B.1. Motivate the student by defining the functions of these members. Accuracy should be stressed saying that if the sill plates are placed inaccurately the building that is erected in it will be inaccurate.	
a. Sill is the member where the wood portion of the structure ties onto the concrete foundation.		
b. Girder is the member that supports floor joists.		
2. Assignment.		
a. Read: (1) Builder 3&2, Chapter 10, (2) Framing, Sheathing and Insulation, Unit 3 and 4.		
C. Establish effect.		
1. Value.	C.1. Bring out need and value of material being presented - state learning objectives.	
a. Pass course.		
b. Perform better on the job.	a. Upon completion of this topic, you will be able to layout, cut and install sills and girders. You will also be able to correctly use carpenter hand tools and portable electric power tools.	
c. Get advanced.		
d. Be a better building.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
D. Overview.		
1. Job sheets.		
a. Follow instructors demonstration on the job sheet.		
b. Job sheets are to help you in the field exercises. Refer to them when in doubt.		
2. Safety precautions in using:		
a. Electric portable circular saw.		
b. Electric portable drill.		
c. Hand saw.		
3. Ask questions any time - raise your hand and be recognized before asking.		
II. Start presentation:		
A. Introduce job sheets.	II.A. Hand out job sheets.	II.A. Job sheets are to be returned at the completion of this topic. However, if you wish to keep a copy for your own, ask the instructor for them.
1. SCBT-150.1-BU-JS-1.1.1.1, "Installing Sill Plates."		
2. SCBT-150.1-BU-JS-1.1.1.2, "Placing and Posting Girders."		
B. Tools and Equipment.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
1. Film.		
a. Introduce film.	1.a. Introduce one film at a time.	
b. Discuss key points.	1.b. Discuss key points prior to each showing of film.	
c. Show film.		
d. Discuss highlights.	1.d. Discuss highlights after showing of film.	1.d. Participate in discussion.
(1) HOW-016, "How to Use Measuring Tools."	(1) Lead discussion.	
(2) HOW-018, "How to Use Saws."	(2) Ask questions.	
(3) HOW-014, "How to Use Hammers."		
(4) HOW-015, "How to Use Hand Boring Tools."		
2. Introduce tools and equipment not in film.	B.2. Show tools and equipment as they are introduced.	
a. Hand level.		
b. Extension cord.		
c. Portable electric circular saw.		
d. Portable electric drill.		
e. Adjustable wrench.		
f. Saw horses.		
g. Chalk line.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
3. Materials. a. 2 x 6's. b. 4 x 4's. c. 4 x 6's. d. 8d box nails. e. 16d duplex nails. f. 16d box nails.	B.3. Show samples of wood pieces and nails to reinforce presentation.	
C. Sills. 1. Definition - bearing members placed on foundation walls. 2. Types. a. Lapped. b. Laminated. c. Solid. d. Box.	II.C. Give a brief lecture on sills and girder. To reinforce lecture use: a. Model on platform frame building. b. Chart(s) illustrating sub-structures of a frame building. c. Transparencies. (1) 11CS-7400055-T. (2) 11CS-7400056-T.	
D. Girders. 1. Definition - bearing members that support floor joists and smaller beams. 2. Types.	II.D. Give brief lecture on girders to reinforce lecture use: a. Model on platform frame building. b. Chart(s) illustrating sub-structures of a frame building. c. Transparency. (1) 11CS-7400057-T.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. Built up.		
b. Solid.		
c. I.		
d. H.		
3. Film.	D.3. Give brief introduction to the film, pointing out the key points to look for in the film and then show the film.	
a. Introduce film.		
b. Discuss key points.		
c. Show film.		
(1) MN-6719B,"Building Technique, Framing Floor Joists and Wall."		
d. Discuss film.	3.d. Lead discussion by asking and answering questions on the film - stress safety.	3.d. Participate in th discussion.
(1) Highlights.		
(2) Safety.		
E. Steps of procedures.	II.E. Take class out to the field to demonstrate - call students attention to job sheet SCBT-150.1-BU-JS-12 .1.1.	II.E. Follow procedure in the demonstration on job sheet.
1. Sill lay out technique.		
a. Prepare first sill section.		
b. Select straight 2 x 6.		
c. Position 2 x 6 member.		
d. Lay out for anchor bolt.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
e. Lay out for sill length.		
2. Sill preparation technique.		
a. Place sill plate section on saw horses.		
b. Use portable electric circular saw to cut sill plate to length. Stress safety in the usage of this saw.		
c. Use portable electric drill to drill required holes - stress the need of a hole 1/8" larger than anchor bolt size.		
3. Sill plate installing technique.		
a. Place sill plate in position, place a washer on each bolt and hand tighten the nuts.		
4. Girder lay out and preparation technique.	E.4. Instructor demonstrates - call student's attention to job sheets.	E.4. Students follow demonstration on job sheet SCBT-150.1-BU-JS-1.2.1.2.
a. Determine length of girder.		
b. Select straight 4 x 6 and place it on saw horses.		
c. Cut girder to length.		
(1) Girder should be cut appoximately 1 inch shorter than space opening.		
d. Run a line taut across the building and on the top of sill plates.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
e. Determine post locations (3) and determine length of each post by subtracting the thickness of the girder member from the distance of post length taken up to the taut line in each post location.	4.f. Demonstrate correct usage of the hand saw.	
f. Measure and cut posts to length.		
g. Place and secure posts to girder.		
h. Place girder in position and brace girder temporarily.		
i. Place sill plate in position, place a washer on each bolt and hand tighten nuts.		
III. Application:		
A. Student practice.		
1. Usage of hand saw by cutting ends of scrap 2 x 4's until a cut is made that is within ± 1/16" of being square.	A.1. Issue tools and materials	A.1. Student practice.
2. Installing sill plates.	A.2. Assign student to teams - 4 men to a team and designate project site. Be available to show, assist and supervise.	A.2. Student practice as a member of a team.
3. Install girder with posts.		
VI. Summary:		
A. Carpenter hand tools.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY

1. Measuring tools.
2. Combination square.
3. Hand level.
4. Framing square.
5. Hammer.
6. Ratchet brace.
7. Auger bit.
8. Adjustable wrench.
9. Cross cut saw.

B. Portable electric power tools.

1. Drill.
2. Circular saw.

C. Substructure members.

1. Sill plates.
2. Girders.
3. Posts.

NAVAL CONSTRUCTION TRAINING CENTER
PORT HUENEME, CALIFORNIA 93043
SPECIAL CONSTRUCTION BATTALION TRAINING COURSE (SCBT) 150.1

Classification: Unclassified

Topic: Floor Joists and Solid Bridging

Average Time: 1 Period (Class)
4 Periods (Pract)

Instructional Materials:

A. Texts.

1. Builder 3&2, NAVPERS 10648-F, Chapter 10.

2. Framing, Sheathing and Insulation, Delmar Publishing Co., Unit 6.

B. References.

1. Practical Carpentry, Goodheart - Wilcox Co.

2. Fundamentals of Carpentry, American Technical Society.

C. Tools and Equipment.

1. Measuring tape.

2. Combination square.

3. Cross cut saw.

4. Framing square.

Terminal Objective: Upon completion of this course the student will have met all the requirements of personnel readiness capability program, skill level 150.1 - Light Frame Construction I involving sill plate, post, girder, floor joist, bridging, sub-flooring, plate, ridge piece and gable end stud. The light frame structure is to be erected by following procedures in accordance with job sheets and to within the requirements as stated on the job sheets.

Enabling Objectives: Upon completion of this topic the student will be able to lay out, cut and install floor joists and solid bridging following procedures in job sheet SCBT-150.1-BU-JS-1.2.2.1, "Floor Joists and Bridging (solid) Layout and Erection." The installed floor framing will be within job sheet specification-.

Criterion Tests: Given the proper tools, materials and job sheet the student will be tested on his ability to correctly use and care for carpenter hand tools and portable electric power tools in performing all tasks outlined in the objectives and within the requirements/tolerances as stated on the job sheets.

Homework: Read: Builder 3&2, Chapter 10, and Framing, Sheathing and Insulation, Unit 6.

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5. Hammer.

6. Chalk line.

7. Portable electric circular saw.

8. Saw horse.

D. Training Aids and Devices.

1. Transparencies.

a. 11CS-10321.101T-5, "Floor Joist Layout."

b. 11CS-7400058-T, "Wood Bridging."

2. Platform frame building (model).

3. Chart(s) illustrating sub-structures of a frame building.

4. Materials.

a. 2 x 6's or 2 x 8's.

5. Locally prepared materials.

a. Job sheet.

(1) SCBT-150.1-BU-JS-1.2.2.1, "Floor Joists and Bridging (solid) Layout and Erection."

E. Training Aids Equipment.

1. Overhead projector.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. Introduction to the lesson:		
A. Establish contact.		
1. Name:	A.1. Introduce self.	
2. Topic: Floor Joists and Solid Bridging	A.2. Introduce topic.	
B. Establish readiness.		
1. Purpose.	B.1. Motivate the students by defining the functions of these members.	
a. Floor joists - members that support the floor.		
b. Solid bridging members that hold floor joists in alignment and for the bracing of the floor joists.		
2. Assignment.		
a. Read.		
(1) Builder 3&2, Chapter 10.		
(2) Framing, Sheathing and Insulation, unit 6.		
C. Establish effect.		
1. Value.	C.1. Bring out need and value of material being presented. State learning objectives.	
a. Pass course.	a. Upon completion of this topic you will be able to lay out, cut and install floor joists and solid bridging.	
b. Perform better on the job.		
c. Get advanced.		
d. Be a better builder.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
D. Overview.		
1. Job sheets.		
a. Follow instructor's demonstration on the job sheet.		
b. Job sheetsare to help you in the field exercises. Refer to them when in doubt.		
2. Safety precautions in working on floor joists - watch where you put your foot.		
3. Ask questions anytime.		
II. Start presentation.		
A. Introduce job sheet.	II.A. Hand out job sheet.	II.A. Job sheet is to be returned at the completion of this topic.
1. SCBT-150.1-BU-JS-1.2.2.1, "Floor Joists and Bridging (solid) Layout and Erection."		
B. Materials.	II.B. Show sample of 2 x 6's and/or 2 x 8's.	II.B. Pay close attention to lecture.
1. 2 x 6's or 2 x 8's.		
C. Floor joists.	II.C. Give brief lecture on floor joists and bridging.	II.C. Pay close attention to lecture.
1. Definition - floor joists are horizontal members supporting the floor.	a. Use model of platform frame building	
2. Types.	b. Use chart(s) illustrating sub-structures of a frame building.	
a. Common.		
b. Trimmer.		
c. Cripple.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
3. Spacing.	C.3. Use transparency, 11CS-10321.101T-5.	
a. 12" on center.		
b. 16" on center.		
c. 24" on center.		
D. Bridging.		
1. The chief purpose of bridging is to hold the joists plumb and in correct alignment. Also helps to distribute load over several joists. Cross bridging is more effective than solid and is most commonly used.		
a. Definition - floor framing member used for the bracing of floor joists.	1.a. Use transparency, 11CS-7400058-T.	
b. Types.		
(1) Solid, to hold floor joists plumb, in alignment and help to distribute load over several joists.		
(2) Cross bridgings or herring bones are more effective in load distribution than the solid bridging.		
E. Steps of procedures.	II.E. Take class out in the field to demonstrate, call students attention to job sheet.	
1. Lay out for floor joists on sill plate.	E.1. Demonstrate layout technique - explain 3/4" set back.	E.1. Follow procedures in demonstration on job sheet.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. Double starter joists.		
b. Keel to mark the 2x's for joist placement.		
c. Mark off 16" for center of first joist.		
d. Set back 3/4" for thickness of 2x's joist.		
e. Layout at 16" on center, emphasize correct placing of 2x's.		
2. Prepare and secure header joists.	E.2. Demonstrate toe-nailing technique.	
a. Select straight, even grained joist member.		
b. Square cut one end.		
c. Align this piece with the end of sill plate and mark for length. All joints on the header joists must be on the center of a floor joist.		
d. Cut to length.		
e. Secure header joist to sill plate.		
f. Square mark joist placement on header joist.		
3. Prepare and secure joist.	E.3. Demonstrate joist nailing technique - stress need of keeping the crown up.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. Square cut one end.		
b. Measure and cut to required length.		
c. Secure to header joist and sill plate.		
d. Secure to girder.		
4. Prepare and secure solid bridging.	E.4. Demonstrate lay out technique.	
a. Square cut one end of scrape floor joist size piece.		
b. Measure and cut to length.		
c. Determine solid bridging placement joists.		
d. Snap chalk line through these points.		
III. Application:		
A. Student practice as a team member in the laying out, preparing and securing the floor joists and solid bridging.	III.A. Be available to show, assist and supervise.	III.A. Student practice as a member of a team.
IV. Summary:		
A. Floor joist.		
B. Solid bridging.		

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SCBT-150.1-BU-IG-1.2.3

NAVAL CONSTRUCTION TRAINING CENTER
PORT HUENEME, CALIFORNIA 93043
SPECIAL CONSTRUCTION BATTALION TRAINING COURSE (SCBT) 150.1

Classification: Unclassified

Topic: Subfloors and Wall Plates

Average Time: 2 Periods (Class)
3 Periods (Pract)

Instructional Materials:

A. Texts.

1. Builder 3&2, NAVPERS 10648-F, Chapter 10.

2. Framing, Sheathing and Insulation, Delmar Publishing Co.

B. References.

1. Practical Carpentry, Goodheart - Wilcox Co.

2. Fundamentals of Carpentry, American Technical Society.

C. Tools and Equipment.

1. Measuring tape.

2. Combination square.

3. Cross cut saw.

4. Framing square.

Terminal Objective: Upon completion of this course the student will have met all the requirements of personnel readiness capability program, skill level 150.1 - Light Frame Construction I involving sill plate, post, girder, floor joist, bridging, sub-flooring, plate, ridge piece and gable end stud. The light frame structure is to be erected by following procedures in accordance with job sheets and to within the requirements as stated on the job sheets.

Enabling Objectives: Upon completion of this topic the student will be able to lay out, cut and install subflooring, and wall plates following procedures in job sheets SCBT 150.1 BU JS 1.2.3.1. "Installing Subfloor" and SCBT 150.1 BU JS 1.2.3.2. "Laying Out Sole and Top Plates". The installed subflooring and sole plates will be within job sheet specifications.

Criterion Tests: Given the proper tools, materials and job sheets the student will be tested on his ability to use and care for carpenter hand tools and portable electric power tools in performing all tasks outlined in the objectives and within the requirements/tolerances stated on the job sheets.

Homework: Read: Builder 3&2, Chapter 10 and Framing, Sheathing and Insulation, Units 9 and 10.

5. Hammer

6. Chalk line.

7. Portable electric circular saw.

8. Saw horses.

9. Nail apron.

D. Training Aids and Devices.

1. Transparencies.

   a. 11CS-10321.101T-3, Rough Opening for windows.

   b. 11CS-10321.101T-4, Rough Opening for doors.

   c. 11CS-7400059-T, Subfloor.

   d. 11CS-7400060-T, Subfloor and Underlay.

   e. NP-311013-3T-8, Sole Plate.

   f. 11CS-7400065-T, Corner Balloon and Platform Framing.

2. Model of platform frame building.

3. Charts illustrating frame structures.

4. Locally prepared materials.

   a. Floor plan.

(1) Size of building.

(2) Size and location of door.

(3) Size and location of window.

b. Job sheets.

(1) SCBT 150.1 BU JS 1.2.3.1. "Installing Subfloor".

(2) SCBT 150.1 BU JS 1.2.3.2. "Laying Out Sole and Top Plates".

5. Materials

a. 3/4" x 4' 0" x 8' 0" plywood.

E. Training Aids Equipment.

1. Overhead projector

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OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. Introduction to the Lesson.		
A. Establish contact.		
1. Name:	A.1. Introduce self.	
2. Topic: Subfloors and Wall Plates.	A.2. Introduce topic.	
B. Establish readiness.		
1. Purpose.	B.1. Motivate the student by defining the function of these members. Accuracy should be stressed in laying out the studs in that inaccurately laid studs will not be able to properly receive the sheathing.	
a. Subfloor is to help reinforce the finish floor that are to be placed over them.		
b. Sole and top plates are members that hold the studs in place.		
2. Assignment.		
a. Read.		
(1) Builder 3&2, Chapter 10.		
(2) Framing, Sheathing and Insulation, units 9 and 10.		
C. Establish effect.		
1. Value.	C.1. Bring out need and value of material being presented. State learning objectives.	
a. Pass course.		
b. Perform better on the job.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Safety precautions.	a. Upon completion of this topic you will be able to lay out, cut and install subflooring and lay out top and sole plates.	
d. Ask questions.		
D. Overview.		
1. Job sheet.		
2. Pay close attention to the demonstration by the instructor.		
3. Safety precaution.		
4. Ask questions.		
5. This topic will be presented in two parts.		
II. Start Presentation (Part I):		
A. Introduce job sheet.	II.A. Hand out job sheets.	II.A. Job sheets are to be returned at the completion of this topic.
1. SCBT 150.1 BU JS 1.2.3.1. "Installing Subfloor".		
2. SCBT 150.1 BU JS 1.2.3.2. "Laying Out Sole and Top Plates".		
B. Materials.	II.B. Show samples of plywood and a piece of 2 x 4.	
1. 3/4" x 4' 0" x 8' 0" plywood.		
2. 2 x 4's.		
C. Subfloor.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
1. Definition - to help reinforce the finished floor that is to be placed over it and to serve as a working surface in the erection of the building.	C.1. Give brief lecture on sub-floor.	
2. Types.	a. Use model of platform frame building.	
a. 1 x's.	b. Use chart(s) illustrating a frame structure.	
b. Plywood.	c. Use Transparencies.	
	(1) 11CS-7400059-T.	
	(2) 11CS-7400060-T.	
D. Wall plates.	D.1. Give brief lecture on sole and top plates.	
1. Definition - members to hold the studs in place.	a. Use model on platform frame building.	
2. Types.	b. Use chart(s) illustrating frame structure.	
a. Sole plate.	c. Use transparencies.	
b. Top plates (double).	(1) 11CS-7400065-T.	
	(2) NP-311013-3T-8.	
E. Studs.		
1. Definition - upright wall member that supports the overhead and the roof.		
2. Types.		
a. Common.		
b. Trimmer.		
c. Cripple.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
F. Framing allowance.		
1. Door.	F.1. Use transparency.	
a. Width - 2 1/2".	a. 11CS-10321.101T-4.	
2. Window.		
a. Width - 2 1/2".		
G. Steps of procedures (Part I).	II.G. Take class out to the field to demonstrate - call student attention to job sheet.	II.G. Follow procedures in the demonstration on the job sheet
1. Subfloor.	1. SCBT 150.1 BU JS 1.2 .3.1.	
a. Lay out for starter course.		
(1) Mark off 48 1/4" from header joist at both ends of building.		
(2) Snap chalk line across the floor joists from these points.		
b. Lay first panel.		
(1) Start flush with starter joist and align with chalk line.		
(2) Secure this piece temporarily.		
(a) All joints must be over a joist.		
c. Lay 2nd panel.		
(1) Lay 2nd panel butt against the 1st panel and in line with chalk line.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Secure this piece temporarily.		
d. Lay and secure remainder of panels temporarily.		
e. At the completion of the first course secure panels.		
III. Application (Part I):		
A. Student practice as a team member in the installation of subflooring.	III.A. Be available to show, assist and supervise.	III.A. Student practice as a team member.
NOTE: At the completion of installing subflooring, call the students together to demonstrate plate lay out technique.		
IV. Start Presentation (Part II):		
A. Lay out for sole plate.	IV.A. Call student attention to job sheets, SCBT 150.1 BU JS 1.2.3.2. and pass out floor plan. Demonstrate lay out technique.	IV.A. Follow demonstration by instructor on the job sheets.
1. Measure in 3 1/2" from the edges at each corner.		
2. Snap chalk line through these points.		
B. Select straight 2 x 4's.		
1. A slight crown is okay.		
C. Align and secure sole plate along the chalk line.		
D. Determine location of doors and windows.	IV.D. Have student turn to floor plan.	IV.D. Turn to floor plan.
	1. One floor plan to each team.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
E. Lay out for doors and windows on sole plate. 1. Locate and mark centers of doors and windows. 2. Place marking "D" for doors and "W" for windows. 3. Allowing 2 1/2" for rough opening mark for trimmer studs. 4. Place "T" for trimmer studs.	IV.E. Demonstrate door and window opening lay out technique - stress importance of putting proper symbol signifying types of studs.	
F. Lay out for studs at 16" on center. 1. Off set 3/4" on first stud. 2. Place an "X" for studs. 3. Place "C" for cripples. 4. Place "T" for trimmers.		
G. Prepare and lay out top plate. 1. Square cut one end of selected 2 x 4 and place it edgewise on the sole plate with the squared end flush with the end of the sole plate. 2. Transpose marking for studs, cripples and trimmer. 3. Top plates are to be joined on a stud.	IV.G. Demonstrate technique in laying out top plate.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
V. Application (Part II):		
A. Student practice in laying out of sole and top plate.	V.A. Be available to show, assist and supervise.	V.A. Student practice in lay out work on one wall section.
VI. Summary:		
A. Subfloor.		
B. Wall plates.		
C. Studs.		
1. Standard.		
2. Trimmer.		
3. Cripple.		
D. Framing allowance.		
1. Door.		
2. Windows.		

SCBT-150.1-BU-IG-1.2.4

NAVAL CONSTRUCTION TRAINING CENTER
PORT HUENEME, CALIFORNIA 93043
SPECIAL CONSTRUCTION BATTALION TRAINING COURSE (SCBT) 150.1

Classification: Unclassified

Topic: Wall Members

Average Time: 2 Periods (Class)
15 Periods (Pract)

Instructional Materials:

A. Texts.

1. Builder 3&2, NAVPERS 10648-F, Chapter 10.

2. Framing, Sheathing and Insulation, Delmar Publishing Co., Unit 10 and 11.

B. References.

1. Fundametals of Carpentry, American Technical Society.

2. Practical Carpentry, Goodheart-Wilcox Co.

C. Tools and Equipment.

1. Measuring tape.

2. Combination square.

3. Hand level.

4. Extension cord.

Terminal Objective: Upon completion of this course the student will have met all the requirements of personnel readiness capability program, skill level 150.1 - Light Frame Construction I involving sill plate, post, girder, floor joist, bridging, sub-flooring, plate, ridge piece and gable end stud. The light frame structure is to be erected by following procedures in accordance with job sheets and to within the requirements as stated on the job sheets.

Enabling Objectives: Upon completion of this topic the student will be able to lay out, cut and install studs, fire blocks, headers, sills and bracing following procedures in accordance with job sheets SCBT-150.1-BU-JS-1.2.4.1, "Erecting and Securing Wall Sections," SCBT-150.1-BU-JS-1.2.4.2, "Installing Fire Blocks and Diagonal Bracing," and SCBT-150.1-BU-JS-1.2.4.3, "Installing Trimmer Studs, Cripple Studs, Sills and Headers."

Criterion Tests: Given the proper tools, materials and job sheets, the student will be tested on his ability to correctly use and care for carpenter hand tools and portable electric power tools in performing all tasks outlined in the objectives and within the requirements/tolerances of the job sheets.

Homework: Read: Builder 3&2, NAVPERS 10648-F, Chapter 10, and Framing, Sheathing and Installation, Units 10 and 11, pp. 91 - 92.

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5. Framing square.

6. Hammer.

7. Portable electric circular saw.

8. Saw horse and step ladder.

9. Chalk line.

10. Nail apron.

D. Training Aids and Devices.

1. Transparencies.

a. NP-311013.3T-13, "Platform Framing."

b. NP-311013.3T-14, "Platform Framing."

c. 11CS-7400063-T, "Wall Backing."

d. NP-311013.3T-9, "Bracing in Framing."

e. NP-311013.3T-12, "Framed Opening (Window)."

2. Chart(s) illustrating structures of a fraem frame building.

3. Locally prepared materials.

a. Job sheets.

(1) SCBT-150.1-BU-JS-1.2.4.1, "Erecting and Securing Wall Sections."

(2) SCBT-150.1-BU-JS-1.2.4.2, "Installing Fire Blocks and Diagonal Bracing."

(3) SCBT-150.1-BU-JS-1.2.4.3, "Installing Trimmer Studs, Cripple Studs, Sills and Headers."

4. Materials.

a. 1 x 6's.

b. 2 x 6's.

E. Training Aids Equipment.

1. Overhead projector.

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OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. Introduction to the Lesson:		
A. Establish contact.		
1. Name:		A.1. Introduce self.
2. Topic: Wall Members.		A.2. Introduce topic.
B. Establish readiness.		
1. Purpose.		B.1. Motivate student by defining the functions of these wall members.
a. Sills and Headers are wall members needed for the rough openings for doors and windows.		
b. Fire block and diagonal bracing are wall members needed to strengthen the wall.		
2. Assignment.		
a. Read.		
(1) Builder 362, Chapter 10.		
(2) Framing, Sheathing and Insulation, Units 10 and 11.		
C. Establish effect.		
1. Value.		C.1. Bring out need and value of material being presented. State learning objectives.
a. Pass course.		
b. Perform better on the job.		a. Upon completion of this topic you will be able to lay out,

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Get advanced.	cut and install studs, fire blocks, headers, sills and bracing for a light frame structure.	
d. Be a better builder.		
D. Overview.		
1. Job sheets.		
2. Pay close attention to demonstration by the instructor.		
3. Safety precautions.		
4. Ask questions.		
II. Start Presentation:		
A. Introduce job sheets.	II.A. Hand out job sheets.	II.A. Job sheets are to be returned at the completion of this topic.
1. SCBT-150.1-BU-JS-1.2.4.1, "Erecting and Securing Wall Sections."		
2. SCBT-150.1-BU-JS-1.2.4.2, "Installing Fire Blocks and Diagonal Bracing."		
3. SCBT-150.1-BU-JS-1.2.4.3, "Installing Trimmer Studs, Cripple Studs, Sills and Headers."		
B. Materials.		
1. 2 x 4's, for this portion of training use scraps of 2 x 4's as much as possible.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
C. Header.	II.C. Give a brief lecture on headers, sills, fire blocks and diagonal bracing - use training aids to reinforce lecture. a. Use model on platform frame building. b. Use chart(s) illustrating structure of frame building. c. Use transparencies, NP-311013.3T-13 NP-311013.3T-14 11CS-7400063-T NP-311013.3t-9 NP-311013.3T-11 NP-311013.3T-12	II.C. Pay attention - asking questions as necessary.
1. Definition - headers are horizontal members over door and window openings, these members distribute the roof load directly over the openings to the trimmer and common studs.		
2. Materials - headers are made of double 2x4's nailed together; 4 x 4's, 4 x 6's, and/or 4 x 12's depending on the size of the opening.		
D. Sills.		
1. Definition - sills are the lower horizontal members used to hold cripple studs in place under window openings.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. Materials - 2 x 4's.		
E. Braces.		
1. Definition - braces are diagonal members used to strengthen the walls, whenever possible they should be placed from upper corner downward to the sole plate.		
2. Types.		
a. Let-in brace.		
b. Cut-in brace.		
F. Plan sequence of raising wall section.		
1. Generally the longest wall section is raised first.		
G. Determine length of stud	II.G. Demonstrate calculating technique of stud length	
1. Overall distance should be 8' - 1" for a 8' - 0" high wall, the 1" is to allow for ceiling material.	8 foot + 1 inch for clearance = 8' 1"	
2. Less thickness of three 2x's or 3 X 1 1/2" = 4 1/2".	less 4 1/2" = 7' 8 1/2"	
	stud length = 7' 8 1/2"	
H. Determine the number of studs that will be needed.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
III. Application:		
A. Student practice as a member of a team in the preparation and raising of wall sections..	III.A. Demonstration is not necessary - however, be available to show, assist and supervise.	III.A. Student practice as a team member, refer to job sheet as necessary.
1. Prepare stud for studding.		
a. Cut studs as necessary.		
b. Distribute studs for wall section.		
2. Nail studs to sole plate and lower member of top plate.		
a. Use two 16d common nails at each end of stud.		
b. If plates are to be joined, join them on a stud.		
c. Select straighter 2 x 4's for corner studs, door openings and window openings.		
3. Secure upper member of top plates.		
a. Off-set as necessary to receive other wall sections.		
b. In overlapping of upper member for a straight wall, overlap must be for at least two studs.		
4. Raise wall section.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
5. Secure sole plate with 16d common nails.		
6. Plumb and temporarily brace this wall section.		
7. Assemble, raise, brace and secure other wall sections.		
8. Install fire blocks.	A.8. Demonstrate use of chalk line as guide for fire blocks.	
a. 48" from subflooring.		
b. Staggered.		
c. Dimension of fire blocks are determined by the spacing of the studs on the sole plate.		
9. Install diagonal bracing.		
a. Braces are best laid at 45° angles.		
10. Remove temporary bracing.		
11. Install trimmer studs.	A.11. State that the standard door height is 6' 8".	
a. Trimmer studs should be the height of the door plus 2 1/2" framing allowance.		
12. Install header.		
a. Header dimension is determined by the space of opening between the studs.		
13. Install sill.		
14. Install cripples.		

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OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY

IV. Summary:

A. Header.

B. Sill.

C. Braces.

D. Fire blocks.

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NAVAL CONSTRUCTION TRAINING CENTER
PORT HUENEME, CALIFORNIA 93043
SPECIAL CONSTRUCTION BATTALION TRAINING (SCBT) 150.1

Classification: Unclassified

Topic: Ceiling Joists and Roof Construction

Average Time: 3 periods (class), 4 periods (pract.)

Instructional Materials:

A. Texts:

1. Builder 3 & 2, NAVPERS 10648-F, Chapter 11.
2. Framing, Sheathing and Insulation, Delmar Publishing Company.

B. References:

1. Fundamentals of Carpentry, American Technical Society.

C. Tools and Equipment:

1. Measuring tape.
2. Combination square.
3. Hand level.
4. Hammer.
5. Framing square.
6. Keel.

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Terminal Objective: Upon completion of this course the student will have met all the requirements of personnel readiness capability program, skill level 150.1 - Light Frame Construction I involving sill plate, post, girder, floor joist, bridging, sub-flooring, plate, ridge piece and gable end stud. The light frame structure is to be erected by following procedures in accordance with job sheets and to within the requirements as stated on the job sheets.

Enabling Objectives: Upon completion of this topic the student will be able to lay out, cut and install ceiling joists and rafters following procedures in accordance with job sheets SCBT 150.1 BU JS 1.2.5.1. "Cutting and Installing Ceiling Joists", SCBT 150.1 BU JS 1.2.5.2., "Raising Roof Frames", and SCBT 150.1 BU JS 1.2.5.3., "Laying Out Common Rafters". The installed ceiling joists and rafters will be within job sheet specifications.

Criterion Test: Given the proper tools, materials and job sheets, the student will be tested on and care for carpenter hand tools and portable electric circular saw in working as a team member in performing all tasks outlined in the objectives and within the requirements/tolerance on the job sheet.

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Homework:

Read Builder 3 & 2, NAVPERS 10648-F, Chapter 11, pp. 318 346.

7. Portable electric circular saw.

8. Saw horses.

9. Cross cut saw.

10. Step ladder.

11. Sliding T-bevel square.

D. Training Aids and Devices.

1. Films:

   a. MN 6719-C Building Technique--Framing, Rafter Principles and Common Rafter (15 min.).

2. Transparencies:

   a. 11CS 11013.101T-2 Platform Western Frame Construction.

   b. 11CS 10321.101T-2 Rafter Cuts.

   c. 11CS 10321.101-T 1 Rafter Measurements.

   d. 11CS 7400064-T Common Rafter Layout.

3. Charts:

   a. Illustrating structures of a frame building (platform), parts of a common rafter.

4. Locally Prepared Material:

   a. Job sheets.

(1) SCBT 150.1 BU JS 1.2.5.1. "Cutting and Installing Ceiling Joists".

(2) SCBT 150.1 BU JS 1.2.5.2. "Raising Roof Frames."

(3) SCBT 150.1 BU JS 1.2.5.3. "Laying out Common Rafters."

E. Training Aids Equipment:

1. 16mm projector.

2. Overhead projector.

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OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. Introduction to the Lesson:		
A. Establish contact.	I.A. Introduce self.	
1. Name:		
2. Topic: Ceiling Joists and Roof Construction	I.A.2. Introduce topic.	
B. Establish readiness.	I.B. Motivate student by defining the function of these members.	
1. Purpose.		
a. Ceiling joists are members supporting the ceiling and holding the walls together.		
b. Rafters are members supporting roof sheathing and roofing.		
2. Assignment.		
a. Read:		
(1) Builder 3 & 2, Chapter 11		
C. Establish effect.		
1. Value.	I.C.1. Bring out need and value of material being presented.	
a. Pass course.	a. Upon completion of this topic you will be able to lay out, cut and install ceiling joists and rafters.	
b. Perform better on the job.		
c. Get advanced.		
d. Be a better builder		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
D. Overview:		
1. Job sheets.		
a. SCBT 150.1 BU JS 1.2.5.1.		
b. SCBT 150.1 BU JS 1.2.5.2.		
c. SCBT 150.1 BU JS 1.2.5.3.		
2. Pay close attention to instruction being given.		
3. Safety precautions.		
4. Ask questions.		
II. Presentation.		
A. Introduce Job Sheets.	II.A. Hand out job sheets.	II.A. Job sheets are to be returned at the completion of this topic.
1. SCBT 150.1 BU JS 1.2.5.1. "Cutting and Installing Ceiling Joists."		
2. SCBT 150.1 BU JS 1.2.5.2. "Raising Roof Frames".		
3. SCBT 150.1 BU JS 1.2.5.3. "Laying out Common Rafters".		
B. Materials:		
1. 2 x 4's for ceiling joists and roof framing members.		
C. Rafter layout terms.	II.C. Give brief lecture on terms. To reinforce lecture, use:	II.C. Take notes.
1. Unit of run.		

OUTLINE OF ACTIVITY	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. Unit of rise.	a. Text - Framing, Sheathing and Insulation, pg. 110-121.	
3. Total run.	b. Use transparencies:	
4. Total rise.	(1) 11CS 11013.101T-2	
5. Span of the building.	(2) 11CS 10321.101T-1.	
6. Projection.	(3) 11CS 7400064T.	
7. Bridge measure.	II.C.7 Demonstrate use of Pythagorean Theory in calculating for bridge measure.	
8. Shortening.		
9. Pitch.	II.C.9. Demonstrate technique in calculating for unit of rise.	
10. Ridge.		
D. Parts of a rafter.	II.D. Give brief lecture on the parts of a common rafter. To reinforce lecture use:	
1. Plumb cut.	a. Chart on parts of a common rafter.	
2. Line length.	b. Transparencies:	
3. Bird's-mouth.	(1) 11CS 10321.101T-2	
4. Tail or overhang.	(2) 11CS 10321.101T-1	
5. Facia cut or tail cut.		
E. Roof framing.		
1. Film	II.E.1 Give a brief introduction to the film, pointing out the key points to look for in the film and then show the film.	
a. Introduce film.		
b. Discuss key points.		
c. Show film.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. Discuss film.	II.E.1.d. Lead discussion by asking and answering questions on the film. Stress safety.	II.E.1.d. Participate in the discussion.
(1) Highlights.		
(2) Safety.		
F. Steps of procedure.	II.F. Take the class out to the field to demonstrate. Call student attention to job sheet SCBT 150.1 BU JS 1.2.5.1.	II.F. Follow procedures in the demonstration on job sheet.
1. Cutting and installing ceiling joists.		
a. Lay out for ceiling joist on top plate.		
(1) First ceiling joist is to be laid 16 3/4" from corner.		
(2) Use "C" marking for ceiling joist placement.		
(3) Mark for ceiling at 16" on center through the length of the building.		
b. Determine the number of ceiling joists necessary.		
(1) Counting the "C" markings.		
c. Prepare ceiling joists.		
(1) Cut joists to length.		
(2) Determine crown.		
(3) Mark off 2" from edge of stock opposite the crown.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(4) Mark off for slope of roof.		
(5) Cut off for slope of roof.		
d. Secure ceiling joists.		
(1) Toe nail ceiling joist over "C" marking with at least 2 16d nails.		
e. Secure backing as necessary.		
2. Rafter layout.	II.F.2. Have student turn to job sheet SCBT 150.1 BU JS 1.2.5.1 as you demonstrate layout technique.	II.F.2. Turn to your job sheet and follow demonstration by the instructor.
a. Step off method.		
b. Using rafter table method.		
3. Raising roof frames.	II.F.3. Call student attention to Job Sheet SCBT 150.1 BU JS 1.2.5.2. Demonstration is not necessary. Go over job sheets with the students.	II.F.3. Turn to your job sheet and follow instruction being given in the job sheet.
a. Lay pathway.		
(1) Sides.		
(2) Center.		
b. Lay out for rafter placement.		
(1) First rafter is to be laid 23 1/4" from corner.		
(2) Use "R" marking for rafter placement.		
(3) Mark off at 2'0" on center through the length of the building.		

(4) Every other rafter should fall alongside a ceiling joist.

c. Lay out and cut ridge member.

(1) Cut one end square.

(2) Lay out for rafters at 2'0" on center. Ridge board joints must be centered on a rafter.

(3) All joints on ridge must fall on a rafter.

d. Distribute rafters.

(1) Place on rafter over each "R" marking on the top plate with the tail end facing outward.

e. Secure rafters to ridge member and raise.

(1) Nail 3 or 4 rafters on one side of the building to the ridge.

(2) Raise this assembly and pull until rafter seats or birds-mouth are resting snugly on the plate.

f. Secure rafters to top plate.

(1) Toe nail rafters to plate with two 16d nails.

(2) Whenever a rafter is alongside a ceiling joist, drive another nail through the rafter into the joist.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
g. Erect rafters on the other half of the building.		
(1) Holding the raised assembly up, raise a couple of rafters and secure rafters to plate.		
(2) Adjust rafters at the ridge.		
(3) Nail roof members together.		
h. Temporary brace erected member.		
(1) Plumb end of ridge to end wall.		
(2) Brace to stud or plate.		
i. Erect remainder of rafters.		
j. Brace erected roof frame.		
(1) Cut and secure ridge support to end wall.		
(2) Brace with 1 x 6's (ridge to ridge support near top plate).		
III. Application.		
A. Student practice individually in laying out a common rafter.	III.A. Issue tools and materials be available to show, assist and supervise.	III.A. Student practice in laying out common rafter.
B. Student practice as a team member in erecting ceiling joists and roof frame members.		III.B. Student work as member of a team in erecting ceiling joists and roof frame.

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SCBT 150.1 BU IG 1.2.5

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY

IV. Summary.

A. Ceiling joist.

B. Rafter layout terms.

1. Unit of run.

2. Unit of rise.

3. Total run.

4. Total rise.

5. Span of the building.

6. Projection.

7. Bridge measure.

8. Shortening.

9. Pitch.

10. Ridge.

C. Parts of a rafter.

1. Plumb cut.

2. Line length.

3. Birds mouth.

4. Tail or overhang.

5. Facia cut or tail cut.

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NAVAL CONSTRUCTION TRAINING CENTER
PORT HUENEME, CALIFORNIA 93043
SPECIAL CONSTRUCTION BATTALION TRAINING (SCBT) 150.1

Classification: Unclassified

Topic: Gable End Studs

Average Time: 1 Period (class), 2 periods (pract.)

Instructional Materials:

A. Texts:

1. Builder 3 & 2, NAVPERS 10648-F Chapter 10.

2. Framing, Sheathing and Insulation, Delmar Publishing Company, Units 14 and 15.

B. References:

1. Fundamentals of Carpentry, American Technical Society.

2. Practical Carpentry, Goodheart-Wilcox Company.

C. Tools and Equipment:

1. Measuring tape.

2. Combination square.

3. Sliding T-bevel square.

4. Hammer.

5. Cross cut saw.

Terminal Objective: Upon completion of this course the student will have met all the requirements of personnel readiness capability program, skill level 150.1 - Light Frame Construction I involving sill plate, post, girder, floor joist, bridging, sub-flooring, plate, ridge piece and gable end stud. The light frame structure is to be erected by following procedures in accordance with job sheets and to within the requirements as stated on the job sheets.

Enabling Objectives: Upon completion of this topic the student will be able to lay out, cut and install gable end studs following procedures in accordance with job sheet SCBT-150.1-BU-JS-1.2.6.1, "Laying Out, Cutting and Installing Gable End Studs." The installed studs will be within job sheet specifications.

Criterion Test: Given the proper tools, materials and job sheets the student will be tested on his ability to correctly use and care for the tools and equipment in performing all the tasks outlined in the objectives and keeping within the tolerances stated above.

Homework: Read

1. Framing, Sheathing and Insulation, Unit 14, pp 110 to 111, Unit 15, pp 124 and 125.

2. Builder 3 & 2, Chapter 13, pp. 362 to 364.

OUTLINE OF INSTRUCTION | INSTRUCTOR ACTIVITY | STUDENT ACTIVITY

6. Framing square

7. Hand level

8. Portable electric circular saw

9. Saw horses

10. Step ladder

D. Training Aids & Devices:

1. Platform frame building (model)

2. Chart(s) illustrating structures of a frame building.

3. Materials: 2 X 4's

4. Locally prepared materials.

a. Job sheets

(1) SCBT-150.1-BU-JS-1.2.6.1, "Laying Out, Cutting and Installing Gable End Studs."

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. Introduction to the Lesson		
A. Establish contact		
1. Name:	I.A.1. Introduce self	
2. Topic: Gable End Studs	I.A.2 Introduce topic	
B. Establish readiness.		
1. Purpose - Gable end studs are to frame up the gable end wall sections.	I.B. Motivate the student by defining the functions of the gable end studs.	
2. Assignment.		
a. Read:		
(1) Builder 3&2, Chapter 13		
(2) Framing, Sheathing and Insulation, Units 14 & 15		
C. Establish effect.	I.C. Bring out the need and value of materials being presented-state learning objectives.	
1. Value		
a. Pass course	a. Upon completion of this topic you will be able to lay out, cut and install gable end studs.	
b. Perform better on the job		
c. Advance in rate		
d. Be a better Builder		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
D. Overview		
1. Job sheet		
a. SCBT-150.1-BU-JS-1.2.6.1.		
2. Pay close attention to the demonstration of the instructor.		
II. Start Presentation		
A. Introduce job sheet		
1. SCBT-150.1-BU-JS-1.2.6.1, Laying Out, Cutting and Installing Gable End Studs."	II.A. Hand out job sheets.	II.A. Job sheets are to be returned at the completion of this topic.
B. Gable end studs	II.B. Give brief lecture on gable end studs. Reinforce lecture with the use of:	
1. Purpose - gable end studs are members used to frame in the ends of gable end wall sections.	a. Model of a platform frame building.	
C. Steps of procedure	b. Chart(s) illustrating structure of a frame building.	
1. Determine line length of first gable end stud.	c. Sample of a gable end stud.	
a. Roof triangle	II.C.1.a. Show location of roof triangle on the chart illustrating structure of a frame building.	
b. Stud spacing 16" o.c.		
c. Ratio and proportion.	II.C.1.c Work sample ratio and proportion problem on chalk board. Assign student similar work problem.	II.C.1.c. Work out assigned problem.
(1) Run: Rise:: 16": line length of first stud.		
Note: The common difference between the length of gable end studs will be this line length.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. Determine actual length of first stud.	II.C.2 Work sample problem on chalk board making allowance for birds-mouth.	
a. Deduct depth of birds-mouth		
3. Lay out and cut first gable end stud.	II.C.3 Take the class out to the field and demonstrate lay out technique.	II.C.3 Ask questions to clarify all doubtful areas.
a. Center of stock		
(1) Face or wide side.		
b. Hold cut of roof on framing square.		
c. Mark on unit of run side of square.		
d. Cut to marking.	II.C.4 Demonstrate laying out technique for second stud.	
4. Determine length of second stud.		
a. Length of first stud plus the common difference acquired in step II.C.1.c.		
I. Application	III.A. Show and assist student having difficulty in calculating and laying out of gable end stud.	III.A. Student work individually in calculating and laying out of first stud.
A. Student practice calculating and laying out of gable end studs.		
B. Student cut and install gable end studs.	III.B. Show, assist and supervise as necessary.	III.B. Student work as a team member in installing gable end studs.
IV. Summary		
A. Length of studs.		
1. Line length.		
2. Actual length		
a. Minus birds-mouth.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
B. Layout		
1. Center of stock		
a. Width side		
2. Framing square		
a. Hold cut of roof		
b. Mark on unit of run side.		
C. Common difference		
1. Equal to line length of first stud.		

SCBT-150.1-BU-IG-1.2.7

NAVAL CONSTRUCTION TRAINING CENTER
PORT HUENEME, CALIFORNIA 93043
SPECIAL CONSTRUCTION BATTALION TRAINING COURSE (SCBT) 150.1

Classification: Unclassified

Topic: Course Summarization

Average Time: 1 Period (Class)
4 Periods (Pract)

Instructional Materials:

A. Texts.

1. Builder 3&2, NAVPERS 10648-F, Chapter 10.

2. Framing, Sheathing and Insulation, Delmar Publishing Co.

B. Reference.

1. Fundamentals of Carpentry, American Technical Society.

C. Tools and Equipment.

1. Hammer.

2. Adjustable wrench.

3. Wrecking bar.

4. Saw horses.

5. Step ladder.

6. Nail apron.

D. Training Aids and Devices: None.

E. Training Aids Equipment: None.

Terminal Objective: Upon completion of this course the student will have met all the requirements of personnel readiness capability program, skill level 150.1 - Light Frame Construction I involving sill plate, post, girder, floor joist, bridging, sub-flooring, plate, ridge piece and gable end stud. The light frame structure is to be erected by following procedures in accordance with job sheets and to within the requirements as stated on the job sheets.

Enabling Objectives: Upon completion of this topic the student will have reinforced his ability to identify by naming all the framing members in accordance with the tests as the members are pointed out by the instructor. The student will also have received the methods used in the erection of the light frame structure as a structure is torn down. The dismanteled framing members will be clear of all nails and will be neatly stacked as they were found at the beginning of this training course.

Criterion Tests: Given the proper tools, the student is to be tested on his ability to safely perform the tasks outlined in the objectives and to within the requirements in the objectives.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. Introduction to the Lesson:		
A. Establish contact..		
1. Name:	A.1. Introduce self.	
2. Topic: Course Summarization.	A.2. Introduce topic.	
B. Establish readiness.		
1. Purpose of this topic is to review what we have learned in this course and to clean up our work area.	B.1. Motivate student by saying that this task will help the student in recalling the procedures used to erect this structure.	
2. Assignment: None.		
C. Establish effect.		
1. Value.		
a. Perform better on the job.		
b. Be a better builder.		
D. Overview.	I.D. State learning objectives.	
1. Stress safety.	1. Upon completion of this topic you will have reinforced your ability to identify the parts of framing member by naming all framing members and you will have reviewed the methods used in the erection of this light frame structure.	
2. Ask questions.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
II. Start presentation:		
A. Framing members and methods of installation.	II.A. Point to each framing member and ask appropriate question pertaining to the member.	II.A. Be alert in answering the questio
1. Ridge board.		
2. Rafter.		
3. Gable end stud.		
4. Ceiling joist.		
5. Top plate.		
6. Stud.		
7. Cut in brace or diagonal brace.		
8. Fire block.		
9. Trimmer stud.		
10. Cripple stud.		
11. Header.		
12. Sill.		
13. Sole plate.		
14. Subflooring.		
15. Floor joist.		
16. Solid bridging.		

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OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
17. Sill plate.		
18. Girder.		
19. Post.		
III. Application:		
A. Student dismantle framing structure and clean up work area.	III.A. Supervise work, stress safety.	III.A. Work as a team member.
IV. Summary:		
A. Sills.		
B. Girder.		
C. Floor joist.		
D. Solid bridging.		
E. Subflooring.		
F. Wall plates.		
G. Studs.		
1. Common.		
2. Cripple.		
3. Trimmer.		
H. Ceiling joist.		
I. Rafter.		
J. Ridge board.		
K. Gable end stud.		

SCBT-150.1-BU-JS-1.2.1.2

NAVAL CONSTRUCTION TRAINING CENTER
PORT HUENEME, CALIFORNIA 93043
SPECIAL CONSTRUCTION BATTALION TRAINING COURSE (SCBT) 150.1

JOB SHEET

Title: Placing and Posting Girders

Introduction: This job sheet is to guide you in the placing and posting of girders.

References:

1. Builder 3&2, NAVPERS 10648-F, Chapter 10.
2. Framing, Sheathing and Insulation, Delmar Publishers, Inc., Unit 4.

Tools and Equipment:

1. Measuring tape.
2. Combination square.
3. Hand level.
4. Framing square.
5. Hammer.
6. Chisel.
7. Portable electric circular saw.
8. Saw horses.

Materials:

1. 4 x 6's.
2. 4 x 4's.
3. 2 x 4's.

Procedures:

1. Select 4 x 6 girder.

   a. By sorting through the lumber pile, select the straightest pieces. A slight crown is O.K.

      (1) The crown is to be kept up.

2. Determine and cut the first girder section to length.

   a. Place one of the selected 2 x 6's on sawhorses.

   b. Using framing square mark one end of the selected piece square.

   c. Using the portable electric circular saw cut this end square.

      (1) Observe all safety precautions while operating the saw.

   d. Using measuring tape determine the distance from foundation wall to center of nailing block on footing foundation.

   e. Add for girder pocket to this length.

   f. Mark 4 x 6 girder piece for desired length.

   g. Same as in step 2c.

3. Determine length for posts.

   a. Run a line taught across the top of the sill plate and over the nailing block on the pier footing.

   b. Measure the distance from line to nailing block.

   c. Subtract the thickness of the girder from this measurement - this new measurement is the length for the post.

4. Measure and cut posts.

   a. Square and cut one end of a 4 x 4.

   b. With the post measurement acquired in step 3, cut posts to length as necessary.

5. Secure end post to girder.

   a. Remove the girder piece from the saw horse and place it on the ground near the installing site with the crowned side down.

b. Nail the end post to the girder.

6. Place and secure girder in position.

a. Erect girder such that the post will be resting on the nailing block.

b. Nail the post to the nailing block.

c. Fasten a temporary brace from the sill plate to the girder.

7. Install intermediate post.

a. Utilizing knowledge gained from step 3, determine the length of the posts.

b. Cut posts to their respective length.

c. Secure the posts to their respective nailing block.

d. Plumb the post and secure the posts to the girder.

8. Prepare and place in position the next girder section.

a. Determine length of next girder section.

b. Select and place another girder piece on the saw horses.

c. Cut on end square.

d. Measure, mark and cut girder section to required length.

e. Following procedure used in the posting of the first girder section, erect and brace second girder section.

9. Prepare, place and secure girder as necessary.

a. Utilizing skill, knowledge gained, proceed to erect the required girders.

10. Align girders.

a. By having one of the men in crew sight and the other rebracing the girders - straighten girders.

11. Clean up work area.

12. Check work with instructor.

    a. Tolerance for girder height is ± 1/8" and the tolerance in alignment is 1/2".

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JOB SHEET

Title: Installing Sill Plates

Introduction: This job sheet is to guide you in installing sill plates.

References:

1. Builder 3&2, NAVPERS 10648-F, Chapter 10.
2. Fundamentals of Carpentry, Durbahm and Sundberg, American Technical Society, pp. 134 - 136.

Tools and Equipment:

1. Measuring tape.
2. Combination square,
3. Portable electric circular saw.
4. Portable electric drill.
5. Drill bit.
6. Adjustable wrench.
7. Electric extension cord.
8. Hammer.
9. Saw horses.

Materials:

1. 2 x 6's.

Procedures:

1. Select straight 2 x 6's for sill plates.
   a. By sorting through the lumber pile select the best pieces available.
2. Prepare the first sill section.
   a. Mark one end of the 2 x 6 square.

b. Using a portable electric circular saw cut the end square.

(1) Observe all safety precautions in operating the portable saw.

3. Lay out sill plate for bolt holes and required length.

a. Lay the 2 x 6 piece on top of the foundation wall and along the inside of anchor bolts.

(1) A sill plate section should have at least 2 bolts.

b. Using a combination square mark square lines across sill member at the center of anchor bolts.

c. Measure the distance from the outside face of the foundation wall to the center of anchor bolts.

d. Transpose this measurement to the 2 x 6 sill section.

e. Mark and square sill plate for length.

4. Cut first sill section to length and bore holes for the bolts.

a. Remove sill section and place it on a pair of saw horses.

b. Using a portable electric circular saw cut the piece to required length.

c. Using a portable electric drill with a drill bit 1/8" larger than the diameter of the anchor bolts, bore the holes.

(1) The 1/8" larger drill bit is to allow for slight adjustment in setting the sill plate.

5. Place the sill plate in position.

a. By taking the sill plate from the sawhorse and placing the plate on the foundation wall and over the bolts.

b. Place a washer and hand tighten each nut on the bolts.

6. Prepare the next sill section.

a. Select another 2 x 6 and place it on the saw horses.

b. Cut one end square.

c. Placing the squared end against the first sill section and against the anchor bolts, lay out for bolt holes and length of new sill section.

d. Remove the new section and placing it on the saw horses cut the sill to length.

e. Bore the holes for the anchor bolts.

7. Prepare and place second sill plate section in position.

a. Same as in step 5.

8. Prepare and place the rest of sill section.

a. Utilizing skill/knowledge gained, lay the remainder of sill plate sections.

9. Cinch the nuts on anchor bolts.

a. Using an adjustable wrench, tighten all nuts.

10. Clean up work area.

11. Check work with the instructor.

a. By calling the instructor to your job site.

(1) Tolerance is ± 1/8" from the face of the foundation wall.

Question:

1. A sill plate section must have at least _____ anchor bolt(s).

SCBT-150.1-BU-JS-1.2.2.1

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SPECIAL CONSTRUCTION BATTALION TRAINING COURSE (SCBT) 150.1

JOB SHEET

Title: Floor Joist and Bridging (Solid) Layout and Erection

Introduction: This job sheet is to guide you in laying out and erecting floor joists and solid bridging.

References:

1. Framing, Sheathing and Insulation, Delmar Publishers, Inc. Unit 6.
2. Fundamentals of Carpentry, pp. 136 - 138.

Tools and Equipment:

1. Measuring tape.
2. Combination square.
3. Cross cut saw.
4. Framing square.
5. Hammer.
6. Portable electric circular saw.
7. Chalk line.
8. Saw horses.

Materials:

1. 2 x 6's.

Procedures:

1. Lay out for joist on the sill plate.
   a. Using a keel mark 2xs for the double starter joists.
      (1) X - designates joist placement.

b. With a pencil and a measuring tape place a mark 15 1/4" from one end for the first joist.

(1) Joists are usually spaced 16" on center. 15 1/4" is the side marking of the first joist with 3/4" allowance for 1/2 the thickness of joist.

c. Using a keel place a "X" mark on the further side.

d. Tack a nail on the 15 1/4" mark.

e. Hook your measuring tape to the nail.

f. Stretching your tape and mark off at 16" intervals to the end of the sill plate.

g. Using a combination square, mark a square line on these marks.

h. Using a keel place "X" marks on the corresponding side of line as in step 1c.

2. Lay out for joist on sill plate on the other side of building.

a. Following procedures in step 1, lay for joist.

(1) Start at the same end.

3. Secure header joist.

a. Select straight, even grained joist pieces and place them on saw horses.

b. Using a combination square, mark one end square.

c. Using a portable electric circular saw, cut this end square.

d. Aligning this end with the end of the sill plate - mark for the length of the header joist.

(1) Joints of header joists should be in the center of a floor joist.

e. Cut joist member square on this mark.

f. Toe nail this header section.

4. Prepare and place second header joist section.

   a. Same as in step 3.

5. Prepare and place the rest of header joist sections.

   a. Utilizing skill/knowledge gained lay the remainder of header joist sections.

6. Prepare and place header joist on the other side of building.

   a. Same as in steps 3, 4 and 5.

7. Prepare and secure floor joists.

   a. Measure and cut floor joist as necessary - the ends toward the header joist must be squared.

   b. Drive nails (16d) through header joist into floor joist and 2 toe nails (16d) through floor joist into sill plate.

      (1) Keep the crown up.

8. Line up floor joist and secure joist to girder.

   a. Assign a man to sight at the end of floor joist to align the joist.

   b. At a given signal secure floor joist on girder with 2 toe nails (16d).

9. Measure the distance between floor joists and record them.

   a. Designate and number the spaces and record the dimensions of the openings as the dimensions are taken.

   b. Gather 2xs floor joist scraps and place them in the area of saw horse and portable circular saw.

   c. Measure, mark and cut pieces as required.

   d. Distribute the cut pieces to their respective openings.

   e. Use a chalk line to strike a line over the girder and on the floor joists.

   f. Use a square and square the floor joist at the mark.

g. Drive 2 nails (16d) through the joist and into the bridge pieces.

10. Clean up work area.

11. Check work with the instructor.

a. By calling the instructor to the work site.

(1) Tolerance for floor joists spacing is 1/8" and the floor joists must be placed with the crown up.

Questions:

1. Joists are normally placed _____ on center.

2. The end joists are to be _____.

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JOB SHEET

TITLE: Installing Subfloor.

INTRODUCTION: This job sheet is to guide you in the installation of subfloor.

REFERENCE:

1. Framing, Sheathing and Insulation, Delmar Publishers, Inc. pp 68 & 69.

TOOLS AND EQUIPMENT:

1. Measuring tape.
2. Cross-cut saw.
3. Hammer.
4. Combination square.
5. Chalkline.
6. Electric circular saw.
7. Electric extension cord.

MATERIALS:

1. 1/2" x 4' -0X8'-0 ply score plywood.
2. 6d common nails.

PROCEDURES:

1. Layout for starter course.
   a. At the corners measure out 48-1/4" from the header joist.
      (1) The 1/4" is allowance for irregularities.
   b. Snap a chalk line through these points.
2. Lay first panel.
   a. Start the first panel flush with the starter joist and lined to the chalk line.
      (1) The other end of the panel must fall on a joist.
   b. Secure this panel temporarily.

3. Lay second panel.

   a. Select and lay the second panel butt against the first panel and in line with the chalk line.

   b. Nail this panel temporarily.

4. Lay remainder of panels.

   a. Same as in step 3.

   b. Measure and cut the last panel to complete the course.

5. Face nail this first course of panels.

   a. Use 6d common nails at 6" on centers around the edges and 10" on centers along the intermediate joists.

6. Lay second row of panels.

   a. The starter panel joint should break on a different joist.

   b. Repeat laying technique until all the panels are laid.

7. Repeat panel laying process until entire flooring is done.

   a. Same as in step 6.

8. Check with instructor.

   a. All floor joints must be on a joist and the wood grain on the panel must be perpendicular to the joists.

QUESTIONS:

1. All panel-end joints must come on the center of a _____.

2. The grain to the panel must run _____ _____ to the joists.

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JOB SHEET

Title: Laying Out Sole and Top Plates.

Introduction: This job is to guide you in laying out sole and top plates.

References: Framing, Sheathing and Insulation, Delmar Publishers, Inc. pp 80.

Tools and Equipment:

1. Measuring tape.
2. Combination square.
3. Cross-cut saw.
4. Hammer.
5. Portable electric circular saw.
6. Chalk line.
7. Electric extension cord.
8. Saw horses.

Materials:

1. 2 x 4's.
2. 16 d common nails.

Procedures:

1. Lay out for sole plate.
   a. Measure in 3 1/2 inches from the outside face of floor joist at each corner of the building.
   b. Snap a chalk line through these points.
2. Select straight 2 x 4's.
   a. By sorting through the 2 x 4's pile select the straighter pieces.
      (1) A slight crown on the 2 x 4's is okay.
3. Align and temporarily secure sole plates.

a. Lay first 2 x 4 piece along the chalk line with one end flush with the outside face of the floor joist.

b. Tack this piece with 16d common box nails at both ends.

c. Lay and secure another 2 x 4, butting one end against the first piece and along the chalk line.

d. Continue this process until the end of the building is reached cutting the last piece such that its end will be flush with the outside face of the floor joist.

e. Continue laying 2 x 4's until sole plates are laid throughout the building.

4. Determine location of doors and windows on the sole plate.

a. From the floor plan provided, locate the centers of all doors and windows.

5. Lay out for doors on the sole plate.

a. Lay out rough openings for doors by adding 2 1/2 inches to the actual size of door..

(1) Size of doors and windows will be given on the floor plan.

b. Divide this dimension by two.

c. From center markings for door, measure out the measurement acquired in step 5b.

d. Using a combination square, square the markings on the plate and place a "C" for cripple on the outside of door rough openings.

e. Allowing the thickness of the 2 x 4 for cripples square off markings for the trimmer stud.

f. Place a "T" for trimmer stud.

6. Lay out for windows on the sole plate.

a. Lay out rough opening for windows by adding 1 1/8" to the actual size of window.

b. Utilizing skills/knowledge gained in step 5, complete laying out of cripples and trimmers.

7. Lay out for studs and cripples on sole plates.

   a. Lay out for corner posts.

   b. "X" markings are for studs.

   c. From the corner measure off 15 1/4 inches and place an "X" alongside the marking away from the corner.

   d. From this new marking stretch your tape and mark off 16" on center, placing "X" markings as you go along.

   e. Whenever the markings fall within the openings, use "C" markings instead of the "X"s.

      (1) "C" for cripples.

8. Prepare top plates.

   a. Square cut one end of selected 2 x 4.

   b. Place it edgewise on the sole plate with the squared end flush with the end of the sole plate.

   c. Mark and cut off top plate member to fall on the center of a stud.

   d. Square cut one end of second selected 2 x 4.

   e. Butt it against the end of the first piece and place it edgewise on the sole plate.

   f. Continue this process until the end of the building is reached.

9. Lay out for studding on top plate.

   a. Adjust combination square so that the blade is protruding 3 3/8" on the square end.

   b. Transpose marking for studs, cripples and trimmer from the sole plate to the top plate.

      (1) Don't forget to put "X"s, "C"s and "T"s as you go along.

10. Prepare and lay out for studs on remainder of top plates.

    a. Utilizing skills/knowledge gained complete top plates lay out work.

11. Check work with instructor.

a. The rough opening of doors and windows must be within ± 1/8" of desired openings, the "X"s, "C"s and "T"s must be on the correct side of markings, every opening must have a "D" or a "W" to designate each opening, and the 16" on centers for studs must be within ± 1/8 inch.

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JOB SHEET

Title: Erecting and Securing Wall Sections.

Introduction: This job sheet is to guide you in the assemblying, erecting and securing of wall sections.

Reference:

1. Builder 3&2, NAVPERS 90648-F, chapter 10.

Tools and Equipment:

1. Measuring tape.
2. Combination square.
3. Cross cut saw.
4. Hammer.
5. Portable electric circular saw.
6. Saw horses.
7. Hand level.
8. Step ladders.

Materials:

1. 2 x 4's.
2. 1" bracing materials.

Procedures:

1. Plan sequence of raising wall sections.
   a. By planning which wall section to raise first and the sequence to follow in raising all wall sections.
      (1) Generally, the longest wall section is raised first.
2. Prepare studs for studding.
   a. Counting the number of X's layed out on the sole plate, determine the amount of studs required.

b. Determine the length of the studs by subtracting 3 thickness of 2 x 4's (4-1/2") from 8' 1" for a 8' 0" high room.

(1) The 1" clearance is to allow for ceiling material and for 8 foot panel or drywall.

c. Using measuring tape, combination square and portable electric circular saw cut the studs.

(1) Observe all safety precautions in operating the portable circular saw.

d. Distribute stud such that a stud is placed over every "X" on the outside wall sole plate. Approximately 3/4 of stud length should be over the subfloor.

3. Prepare and nail studs to the lower member of top plates.

a. Place the first lower member of the top plates with the "X" markings facing the end of the studs on subfloor.

b. Drive 2 16d common nails through sole plate and top plate into studs. The edges of plate and studs should be flush.

(1) Save straight stud pieces for the corners and openings.

4. Prepare and secure upper member of top plates.

a. Square cut a straight piece of 2 x 4 approximately 2' - 6" shorter than the 1st lower top plate member.

(1) This is to be the upper top plate member.

b. Measure in 3 1/2" or the width of a 2 x 4 from the corner portion of lower top plate member.

c. From this off set mark, nail the upper to the lower top plate member with 16d common nails. Nails are to be driven in at approximately 16" apart and should be staggered 1" in from the edges.

d. Square cut a straight piece of 2 x 4 the same length as the 2nd section of lower top plate.

e. Butt this piece against the upper member of the 1st section and mark off set that will be required in tying on the 2nd to the 1st section.

5. Raise the 1st wall section.

   a. By having a group of men together, raise the 1st section up, placing the lower portion on marked guide line.

   b. While some of the men are holding this section upright, nail the sole plate in place with 16d common nails.

      (1) Edges of plate and studs should be nailed flush.

6. Plumb and temporarily brace the 1st wall section.

   a. Using double headed nails tack 1x material about a foot from the outside top of the corner stud, and running parallel to the plate.

      (1) Brace is considered most effective at 45°.

   b. Using a hand level, plumb the corner stud.

   c. Using a double headed nail tack the brace as the corner stud is held plumb.

   d. Tack 1x materials as needed for bracing the wall perpendicular to the plates.

      (1) A 2x scrap may have to be nailed on subfloor for the other end of bracing members.

   e. Utilizing skills/knowledge gained, temporarily brace this wall section.

7. Assemble, raise and brace 2nd wall section.

   a. Nail the stud to the 2nd section of lower top plate.

   b. Offsetting the mark acquired in step 4e nail the 2nd upper to the lower plate.

   c. Square cut a straight piece of 2 x 4 the same length as the next section.

   d. Butt this piece against the upper member of the 2nd section and mark off-set that will be required for the next section.

e. Raise the wnd wall section and nail the overlapping upper top plate of the 2nd to the 1st section.

f. Using procedures in the bracing of the 1st section brace the 2nd section.

8. Assemble, raise and brace remainder of wall sections.

a. Utilizing skills/knowledge gained erect all of the wall sections.

9. Recheck plumb of building frame.

a. Plumb all corners, making adjustments as necessary.

10. Check work with instructor.

a. Call instructor to check work for accuracy.

(1) Tolerance of studding is ± 1/8" of 16" on center and the corners of the building must be within 1/4" to plumb for the full height of the wall.

NOTE: For intersecting partition wall sections, the width of a 2 x 4 should be left out of the upper top plate.

Questions:

1. The distance from top of sub-floor to the top of top plates of a 8'-0" high room is _____.

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JOB SHEET

Title: Installing Fire Block and Diagonal Braces.

Introduction: This job sheet is to guide you in installing fire blocks and diagonal braces.

Reference:

1. Fundamentals of Carpentry, Durbahn and Sundberg, pp. 93.

Tools and Equipment:

1. Measuring tape.
2. Hammer.
3. Cross cut saw.
4. Chalk line.
5. Combination sqaure.
6. Portable electric circular saw.
7. Saw horses.

Procedures:

1. Mark for fire block.
   a. Measure and mark 48" from sub-floor on corner studs throughout the room.
   b. Using a chalk line strike a line through the points.
2. Square the mark.
   a. Using a combination square, square both faces of studs at the line.
3. Prepare and secure fire blocks.

a. Taking measurements for fire block from the spacing on the sole plate, square cut blocks for each opening.

b. Secure the blocks with 2 - 16d common nails at each end, block in one opening above the line and below the line on the next opening.

4. Check work with instructor.

5. Mark for diagonal bracing.

a. From the top of corner stud mark out 1" onto the top plate.

b. Locate a point on the sole plate that is a stud height away from the corner stud.

(1) Best braces are laid at 45°.

c. Using a chalk line strike a line through these marks.

6. Lay out, cut and secure braces.

a. Gather 2 x 4 scraps long enough for bracing.

b. Lay 2 x 4 pieces alongside and below the chalk line and scribe required angles.

c. Using a portable electric circular saw and/or crosscut saw, cut the scribed angles.

d Secure braces with 2 - 6d common nails at each end.

7. Remove temporary brace.

a. By removing the double headed nails used on the temporary braces.

8. Check work with instructor.

a. Tolerance of the fire blocks at the diagonal bracings is $\pm$ 1/8" at the cut and these members must be secured with $\pm$ 1/8" of the chalk line.

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JOB SHEET

Title: Installing Trimmer Studs, Cripple Studs, Sills and Headers

Introduction: This job sheet is to guide you in the installation of trimmer studs, cripple studs, sills and headers.

Reference:

1. Builder 3&2, NAVPERS 10648-F, Chapter 10, pp. 312 - 315.

Tools and Equipment:

1. Measuring tape.
2. Combination square.
3. Cross cut saw.
4. Hammer.
5. Portable electric circular saw.
6. Saw horses.
7. Step ladders.

Materials:

1. 2 x 4's.

Procedures:

1. Determine the number of trimmer studs required.
   a. By counting the number openings and doubling the number.
      (1) Trimmer studs for door and window openings are alike.
2. Determine the length of trimmer studs.
   a. By adding 1" to the length or height of the doors or by details given by the instructor.
3. Prepare and install trimmer studs.
   a. Selecting straight 2 x 4's square cut the required number of trimmer stud to the desired length.

b. Distribute 2 trimmer studs to each opening.

c. Nail trimmer studs flush with the opening studs by driving 5 16d common nails through trimmer studs into the opening stud.

4. Prepare and install headers.

a. Determine length of header for an opening by measuring the distance between opening studs.

(1) Not distance between trimmer studs.

b. Square cut 2-2 x 6's to the required length for each opening.

c. Nail the two pieces together with six 16d nails.

d. Place the nailed pieces edgewise on the trimmer stud flush with the outside edge of the studs.

e. Drive three 16d common nails through the studs and into the header member at each end.

5. Prepare and install cripple studs for opening over the header.

a. Length of cripple studs is determined by measuring the distance between the head and top plates.

b. The number of cripple studs over the header that is needed is determined by counting the "C" marks on the sole plate, plus two more for each opening.

(1) The two more cripple studs are to be used over the trimmers.

c. Square cut scraps of 2 x 4's to the desired length.

d. Position cripple studs in place and secure with two 8d common nails (tool) at each end.

6. Prepare and install cripple studs for window opening below the sill.

a. Referring to details given by the instructor as to the rough opening of a window determine the required height of opening.

b. From the bottom of the header measure down and mark required opening.

c. Subtract this distance by one thickness of a 2 x 4 to determine length of cripple stud.

d. Determine the number of window opening cripple studs by counting the "C" marks on the sole plate.

e. Square cut required amount of cripple stud to the desired length.

f. Nail a cripple stud flush with the window opening trimmer stud with four 16d common nails.

g. Determine length of sill for window opening by measuring the distance between trimmer studs.

h. Square cut one 2 x 4 to the required length for each opening.

i. Place this piece along side sole plate and transpose "C" marking from sole plate to it.

j. Nail cripple studs to "C" sill piece.

k. Place this assembled piece in position and secure with two 16d common nails at each end.

l. Toe nail cripples to sole plate with four 8d common nails.

7. Check work with instructor.

a. All trimmer studs must be within a tolerance of $\pm$ 1/8" and the rough openings for windows and doors must be within a tolerance for $\pm$ 1/8" as given on the floor plan.

Questions:

1. Length of door headers are determined by the distance between _____.

2. Length of window sills are determined by the distance between _____.

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JOB SHEET

TITLE: Cutting and Installing Ceiling Joists.

INTRODUCTION: This job is to guide you in cutting and installing ceiling Joists.

REFERENCES:

1. Framing, Sheathing and Insulation, Delmar Publishers, Inc.

TOOLS AND EQUIPMENT:

1. Measuring tape.
2. Combination square.
3. Framing square.
4. Hammer.
5. Portable electric circular saw.
6. Keel.
7. Saw horses.
8. Step ladder.

MATERIALS:

1. 2 x 4's.

PROCEDURES:

1. Lay out for ceiling joist on the top plate.
   a. From a corner of a building, mark off 16 3/4 inches for the first ceiling joist.
      (1) The third ceiling joist will fall alongside a rafter member which are placed at 24" on center.
   b. Place a "C" mark on the side of the mark further away from the corner.
   c. At 16" on center, mark through the remainder of the building.
2. Lay out for joist on the other side of the building.

3. Determine the number of ceiling joists necessary.

   a. By counting the number of "C"s on the top plate.

4. Prepare ceiling joists.

   a. Cut ceiling joists to the span of the building.

   b. From the edge opposite the crown, mark off 2 inches.

   c. Using a framing square, mark off for slope of roof.

   d. Cut this marking off.

5. Secure ceiling joists.

   a. By toe nailing a joist over the "C" markings.

      (1) Ceiling joists must be secured with at least two (2) 16d box nails at each end.

6. Secure backing as necessary.

   a. By nailing 2 x 4 over the top plates with 1/2 of the width of 2 x 4 overlapping the plates on the side(s) requiring a backing.

7. Check work with instructor.

   a. Ceiling joists must be laid within 1/8" at 16" on center and must be secured with at least two (2) 16d nails and must be laid with the crown up.

QUESTIONS:

1. Ceiling joists are normally _____ inches on center.

2. The crown of the joist must be always _____ .

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JOB SHEET

TITLE: Raising Roof Frames.

INTRODUCTION: This job sheet is to guide in the raising of roof frames.

REFERENCES:

1. Builder 3 & 2, NAVPERS 10648-F, Chapter 11, pp 318-346.
2. Framing, Sheathing and Insulation, Delmar Publishers Inc. pp 122-124.

TOOLS AND EQUIPMENT:

1. Measuring tape.
2. Combination square.
3. Hand level.
4. Hammer.
5. Framing square.
6. Portable electric circular saw.
7. Keel.
8. Saw horses.
9. Step ladder

MATERIALS:

1. 2 x 4 rafters (pre-cut), 1 x 10"s or 1 x 12"s.
2. Nails

PROCEDURES:

1. Lay pathway.
   a. Placing and tacking down 1 x 10"s or 1 x 12"s over the ceiling joists, along the sides of the building, and away from the side walls with ample clearance for rafters.
   b. Placing and tacking down the 1 x"s over the ceiling joists and along the center of the building.

2. Lay out for rafter placement.

   a. From the corner, place a mark 23 1/4 " for the first rafter on the top plate.

      (1) Normally rafters are laid 2'0" on center.

   b. Place an "R" marking on the side of the mark away from the corner.

   c. Mark off for rafters at 24" on center throughout the length of the building.

      (1) Every other rafter should fall alongside a ceiling joist.

3. Lay out and cut ridge member.

   a. Cut one end square.

      (1) A straight piece should be selected for a ridge member.

   b. As in step 2, lay out for rafters on ridge member.

   c. If ridge member is not long enough to span the length of the building, and joints are necessary, the joints must fall on the middle of the rafter.

4. Distribute rafters.

   a. Place a rafter on the pathway in the proximity of every "R" marking on the top plate with the tail end of the rafter facing outward.

5. Secure rafters to ridge member and raise.

   a. Use 2-16d box or common nails for 2 x's and 2-8d nails for 1 x's ridge pieces.

   b. Secure 3 or 4 rafters on one side of building to ridge.

   c. With one man at each end of ridge, pull and raise ridge member until rafter seat cuts are resting snugly on the top plate.

      (1) For optimum efficiency, a four man crew is best.

6. Secure rafters to top plate.

   a. Nail rafters to top plate with 2-16d nails (toe nail).

   b. Whenever a rafter is laid alongside a ceiling joist, drive another nail through the rafter into the ceiling joist.

7. Erect rafters on other half of building.

   a. Holding the raised assembly up and raising a couple of rafters on the other side of the building, secure rafters to the top plate.

   b. Adjust rafters to meet at the ridge.

   c. Secure roof members together.

8. Temporary brace erected members.

   a. Plumb the end of ridge to end wall.

   b. Use 1 x 6"s to brace erected section (ridge to stud or plate).

9. Raise and secure remainder of rafters.

   a. With one man working at the center and another man at the side of the building.

10. Brace erected roof fr[illegible].

    a. Cut and secure a 2 x 4 for ridge support to the top of end wall section.

    b. Use 1 x 6"s to brace ridge member to the 2 x 4 support member.

11. Check work with instructor.

    a. Rafters must be laid within 1/8" [illegible] 2'0" on center. The seat cut must be secured snugly to the p[illegible] and the ridge support member must be plumb to within 1/16" the leng[illegible] of a hand level.

QUESTIONS:

1. Rafters are normally spaced _____ feet on center.

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JOB SHEET

Title: Laying Out Common Rafter

Introduction: This job sheet is to guide you in the laying out of a common rafter.

Tools and Equipment:

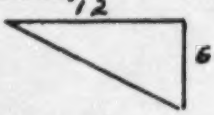
1. Measuring tape.
2. Framing square.
3. Combination square.
4. Cross cut saw.
5. Portable electric circular saw.
6. Saw horses.
7. Pencil.

Materials:

1. 2 x 4's.

Procedures:

1. Determine the span of the building.
   a. By refering to the floor plan.
2. Determine the unit of rise.
   a. By refering to the elevation plan and/or the sectional drawing.
   b. Will be shown thusly:



3. Determine bridge measure using pythagorean theory.

a. Use Pythagorean Theory equation:

$a^2 + b^2 = c^2$.

Given: a = 12
b = 6

Step 1: $(12 \times 12) + (6 \times 6) = c^2$
$144 + 36 = c^2$
$180 = c^2$

Step 2:

$$\begin{array}{r} 13.416 \\ \sqrt{180.00,00,00} \\ 1 \\ \underline{23/80} \\ 69 \\ \underline{264/1100} \\ 1056 \\ \underline{26810/4400} \\ 2681 \\ \underline{26826/171900} \\ 160956 \\ 9944 - R \end{array}$$

The bridge measure is 13.416 inches.

4. Determine bridge measure using the rafter schedule.

a. From the rafter schedule on your framing square, read the numbers given on the first line under the number 6. The number should read 13.42.

5. Determine line length of common rafter.

a. Multiply the bridge measure and the total run (in feet) equation.

Step 1:

$$\begin{array}{r} 13.416 \\ \times \quad 11 \\ \hline 13416 \\ \underline{13416} \\ 147.576 \text{ inches.} \end{array}$$

Step 2:
```
      12
  12 ) 147.576
       12
       27
       24
        3
```

12 feet 2.576 inches.

b. The total run is one half the span, equate:

span = 22 feet

22 ÷ 2 = 11 feet

total run = 11 feet

Step 3:
```
   .576
 X  16
  3456
 576
 9.216
```

The line length is 12 ft. 3 9/16 inch.

6. Determine length of projection and the length of tail.

a. By refering to the elevation plan and/or sectional drawing.

b. Multiply the bridge measurement and length of the porjection (in feet), equate:

projection = 18"

18" = 1 1/2 feet.

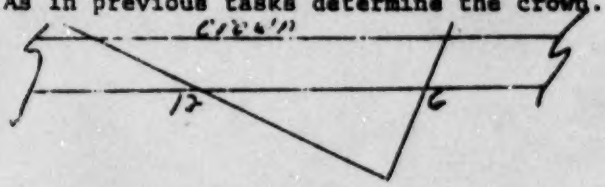
```
 13.416
 X  1.5
  67080
 13416
 20.1240
```

Tail length is 20 1/8" or 1' 8 1/8"

7. Layout common rafter line length.

a. Select a straight 2 x 4 and set it on a pair of saw horses.

b. As in previous tasks determine the crown.



c. By holding the framing square with the body on 12 and the tongue on 6. Strike a plumb mark on the tongue at the end of the 2 x 4 such that the crown will be up.

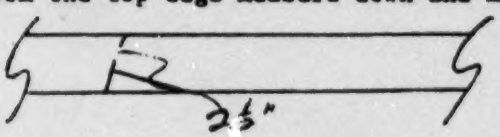
d. From the long point of the mark, measure out the line length determined in step 5 (12' 3 9/16").

8. Lay out for bird's mouth.

a. Square the top of the 2 x 4 at the mark.

b. Using the framing square run a plumb line down the side of the 2 x 4.

c. From the top edge measure down and mark 2 1/2".



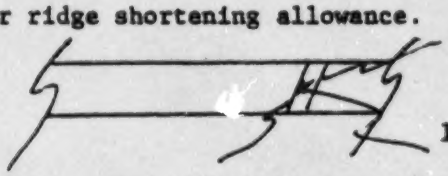
d. Using a framing square run a level line at this mark. This level line is called seat cut.

9. Lay out for tail.

a. Refer to step 6 for length of tail

b. Utilizing skills gained from previous tasks, mark for tail.

10. Lay out for ridge shortening allowance.



a. From the plumb line marked in step 7, measure back one half the thickness of the ridge board. This half thickness must be taken perpendicualr from the original plumb line.

b. Mark new plumb line and scratch out the original mark.

c. Scratch out old marking to eliminate cutting on the wrong mark.

11. Check work with instructor.

a. Raise your hand or call instructor.

b. The lay out work must show the total rafter length to be within ± 1/8" of the correct length. The lumber to be left after cutting the birds mouth must be within 2 7/16" - 2 9/16" and the rafter must be laid out with the crown up.

12. Cut your rafter.

a. Using the tools and equipment assigned.

Questions:

1. The pitch is equal to the _____ over the _____.

2. Line length of a rafter is determined by multiplying the _____, _____ and the _____ of the building.

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JOB SHEET

Title: Laying Out, Cutting and Installing Gable End Studs

Introduction: This job sheet is to guide you in the project of laying out and installing gable end studs.

References:

1. Builder 3&2, NAVPERS 10648-F, Chapter 10, pp. 134.
2. Framing, Sheathing and Insulation, Unit 14, pp. 110 - 111, and Unit 15, pp. 124 - 125.

Tools and Equipment:

1. Measuring tape.
2. Combination square.
3. Sliding T bevel.
4. Hammer.
5. Cross cut saw.
6. Framing square.
7. Hand level.
8. Portable electric circular saw.
9. Step ladder.
10. Saw horses.

Materials:

1. 2 x 4's.

Procedures:

1. Determine the length of the first gable end stud.
   a. From the drawing, determine the on center spacing between studs and locate the roof triangle.

b. Knowing that the studs are 16" O.C. and the roof triangle indicates there is 6" of rise per foot of run, we can determine the line length of the first gable end stud through ratio and proportion. U. RUN: U. Rise ::16" x 12: 6:: 16: x = 8".

2. Determine actual length of first gable end stud.

a. From the line length deduct the depth of the rafter birdsmouth.

3. Lay out and cut first gable end stud.

a. Measure up the center of the width of a piece of 2" x 4" stock.

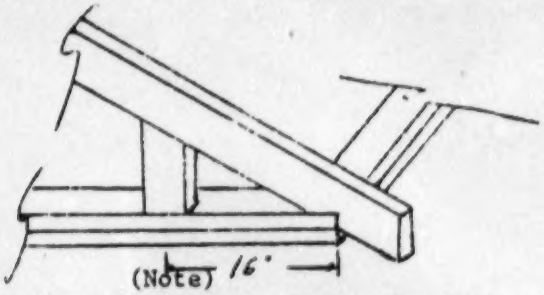
and mark the actual length of the gable end stud.

b. Hold the unit of run and unit of rise on the framing square and mark the angle cut on the unit of rise side of the square.

4. Cut and check first gable end stud.

a. Cut along the mark on waste side of stock.

b. Set the stud in its proper location and measure the distance between the outside edge of the building and the center of the stud. It should read 16".



The common difference between all of the gable end studs will be equal to the line length of the first stud.

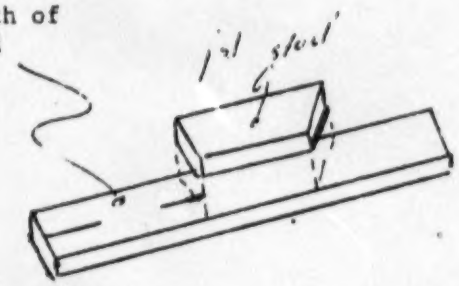
5. Lay out and cut the second gable end stud.

a. The line length of the second stud will be equal to the line length of the first stud X 2 - the depth of the birdsmouth.

(Note)

A simple method of lay out is to measure up the center of a piece of stock, the line length of the first stud, then lay the first stud on this stock and strike a mark along the angle as shown below.

Line length of first stud



With this method, the allowance for the birdsmouth has already been made and the second stud is ready to be cut.

6. Check work with instructor.

a. Tolerance of angle cut on the gable end stud is + 1/8" and the spacing of the studs must be within 1/8" of 16" on center.